KNOWLEDGE MANAGEMENT STRATEGIES AND PRACTICES IN NIGERIAN AGRICULTURAL RESEARCH INSTITUTES

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Thesis submitted in fulfilment of the requirements for the award of degree of Doctor of Philosophy (Information Studies) in the School of Social Sciences, College of Humanities, University of KwaZulu-Natal, Pietermaritzburg Campus, South Africa.

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Submitted: December, 2015

DECLARATION

I, **Kabiru Dahiru Abbas,** declare that:

(i) The research reported in this thesis, except where otherwise indicated, is my original work.

(ii) This thesis has not been submitted for any degree or examination at any other university.

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ABSTRACT

This study was carried out to investigate knowledge management strategies and practices in Nigerian agricultural research institutes. Five institutes located in different geo-political zones of the country were studied namely: Institute for Agricultural Research, Zaria; Institute of Agricultural Research and Training, Ibadan; National Root Crops Research Institute, Umudike; National Cereals Research Institute, Badeggi; and Lake Chad Research Institute, Maiduguri.

The Nonaka and Takeuchi (1995) knowledge creation theory complemented by Boisot's (1987) knowledge category model, Grant's (1996) knowledge-based theory, Conner and Prahalad (1996) resource-based view, Sanchez's (2001a) competence-based view, Ginsberg's (1994) cognitive-frameworks theory, and Teece *et al.* (1997) capability perspective theoretical lenses underpinned the study.

The study was underpinned by post-positivists paradigm, while mixed methods (qualitative and quantitative approaches) using survey questionnaire, interviews and documentary analysis were used for the collection of data. A survey questionnaire was administered on 276 research scientists, while a semi-structured interview was conducted with five directors and five heads of information and documentations of the institutes. Qualitative data were analysed using thematic analysis, while quantitative data were analysed using SPSS version 20.0 to generate descriptive and inferential statistics for actualising the objectives of the study. Reliability and validity of the instruments was ascertained through test-retest reliability using Cronbach's Alpha on 30 research scientists. The expected reliability stood at r=0.786, which is considered acceptable. The study adhered to the ethical protocol of the University of KwaZulu-Natal.

The findings show that the types of knowledge generated by the institutes included: genetic improvement of varieties of cereals, crops, roots, tubers and barley; wheat, rice, soybeans, sugarcane, beniseed, millet; crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation; crop improvement and management practices; generation of agricultural technologies and management practices; pest management, agronomic practices and improved seeds; fish production and management practices. The study found that generations of explicit knowledge and tacit knowledge was high in the institutes.

Besides, the explicit knowledge generation was enhanced by the constant documentation of research findings and research reports, seminars, workshops and conference papers; while tacit knowledge generation was facilitated by knowledge sharing through formal and informal engagements such as review meetings, cropping scheme meetings, community of practice, community of knowledge, knowledge networks and regular staff meetings. The study further found that personalisation strategy (human-based) was the dominant strategy used to derive research and innovations, compared to codification strategy (ICT-based). The study established that knowledge transmission to stakeholders such as farmers, Agricultural Development Partners (ADPs) and other governmental and non-governmental organisations was done largely via newsletters and bulletins, followed by personal contact with research scientists and extension agents. The study found that the following knowledge management systems were in place: document management systems (word processing and desktop databases); organisational practice and routines (group collaboration systems, discussion forums and work flows); training and knowledge intelligence, (community of knowledge, knowledge networks, knowledge culture, intelligent agents and rule-based personalization). The findings revealed lack of knowledge management policies, knowledge management strategic plans and position of knowledge manager in the institutes' organogram.

The study concluded that knowledge management practices in research institutes studied in Nigeria were influenced by knowledge creation, knowledge acquisition and generation, knowledge sharing and modes of knowledge dissemination. The study recommends an agricultural research impact assessment in the institutes in order to ascertain the contribution of the knowledge generated to the revival of the agricultural sector in Nigeria. Coordination, cooperation and collaboration among the farmers, research scientists, research institutes, Agricultural Development Partners (ADPs), and the National Agricultural Research System (NARS) should be enhanced by establishing a national agricultural research database/databank to facilitate access to agricultural research in the institutes. The research institutes should consider putting in place knowledge management policy for efficient management of knowledge resources.

The originality of the study lies in its ability to investigate how concepts and variables from the Nonaka and another six theories/models played out in the Nigerian agricultural research institutes. The study demonstrated the usefulness of these theories and models in the context of Nigerian agricultural research institutes. The study contributes to policy, theory, practice and society. For example, the findings have the potential to influence the formulation of KM policies in the Nigerian agricultural research institutes. In addition the study has provides a deeper understanding of various phenomena pertaining to the KM in the agricultural sector which could serve as a basis for re-evaluation, re-strategising and re-focusing KM practices in the research institutes. The study contributes to the domain body of knowledge and literature, especially in the context of Nigeria. The study proposes a model for KM in agricultural research institutes, which builds upon the weaknesses of the Nonaka model, and other six models discussed in the thesis.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABU	Ahmadu Bello University
ADP	Agricultural Development Partner
ARS	Agricultural Research Station
ARTS	Agricultural Research & Training Station
ARCN	Agricultural Research Council of Nigeria
AROC	Agricultural Research Outreach Centres
CABI	Commonwealth Agricultural Bureaux International
CIS	Community Innovation Survey
CIA	Central Intelligence Agency of the United States of America
CKO	Chief Knowledge Officer
EIA	Energy Information Administration of the United States of America
FARTS	Federal Agricultural Research & Training Station
GARA	Global Agricultural Research Archive
GDP	Gross Domestic Product
HRM	Human Resource Management
I.A.R.	Institute for Agricultural Research
I.A.R. & T.	Institute of Agricultural Research & Training
IC	Intellectual Capital
ICT	Information and Communication Technology
IDI	International Development Index
IITA	International Institute for Tropical Agriculture
IM	Information Management
IRS	Irrigation Research Station
IS	Information System
ITU	International Telecommunication Union
KBV	Knowledge-Based View
KC	Knowledge Centre
KM	Knowledge Management
KMS	Knowledge Management System

LCRI	Lake Chad Research Institute
LGP	Length of Growing Period
LO	Learning Organisation
NAERLS	National Agricultural Extension and Liaison Services
NARS	National Agricultural Research System
NARI	National Agricultural Research Institute
NCRI	National Cereals Research Institute
NGO	Non-Governmental Organisation
NRCRI	National Root Crops Research Institute
OAU	Obafemi Awolowo University
RBV	Resource-Based View
R&D	Research and Development
SSA	Sub-Saharan Africa
UK	United Kingdom
UN	United Nations
USA	United States of America
VSAT	Very Small Aperture Terminal
WWW	World Wide Web

CHAPTER ONE

INTRODUCTION

1.1 Context of the study

According to Drucker (1993), the basic economic resource – 'the means of production' – is no longer capital, labour or natural resources, it is knowledge. The dynamics of the era of globalisation has obliged companies to search internally for their best core competencies to face the challenges of their future requirements. Nations around the globe reacted differently to the dynamic changes that influenced their economies, as the economic language has changed from seeking economies of scale based purely on productivity and return on investment to managing what is now called the knowledge economy. We have seen a key move in developed economies from production-based to serviced-based economies reliant on skilled professionals and sophisticated technologies (Neef, 1999). The World Bank states that knowledge may be the critical factor in development and the means by which poverty and social exclusion can be eliminated (Morrow, 2001).

The creation of an economy in which knowledge-based industries are the leading industries is the goal of government policy and focus in a number of countries (e.g. the UK, Singapore, the U.S.A., Malaysia and Australia) (Morrow, 2001). In 1597, Francis Bacon wrote 'knowledge is power' (Barclay, 2000). In 1962, at a White House reception to honour Nobel Prize winners, President John F. Kennedy said 'in a time of turbulence and change, it is truer than ever that knowledge is power'. He further stressed 'Knowledge is the only meaningful resource today'; businesses and organisations are well advised to manage knowledge as effectively as possible. Knowledge is the fundamental basis of competition (Zack, 1999a). In the knowledge society, employees will have a different relationship to employers and to work itself (Drucker, 2000). In an economy, where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge (Nonaka, 1991). A new economy is emerging built on knowledge and innovation and at its centre are knowledge workers, whose mission is not just to create a world of new products and services, but also to rethink the larger purposes and day-to-day practices of the world of business (Ruggles and Holthouse, 1999). Knowledge management (KM) has become the latest strategy in increasing organisational competitiveness (Bell and Jackson, 2001). KM in organisations can lead to the creation of new technology, a new product, a new product design, a new product process, a new marketing approach, a new form of distribution, or a new way of servicing customers (Ronald, 2004). The World Bank's new strategy is about changing from seeing its product as money to seeing its product as knowledge (Ruggles and Holthouse, 1999). KM is seen as the process of critically managing knowledge to meet present needs, to identify and exploit existing and acquired knowledge assets and artefacts and to develop new knowledge in order to take advantage of new opportunities and challenges (Quintas et al., 1997). Birkinshaw and Sheehan (2002) and Tidd *et al.* (2001) contend that there is a strong link between KM and the financial returns of firms. The central purpose of KM is to transform information and intellectual assets into enduring value (Metcalfe, 2005). The rapidly evolving information landscape has demonstrated a need for new KM methods and practices. The information lifecycle is at the core of understanding how knowledge can be used to support the functions of research organisations such as Nigerian agricultural research institutes for competitive advantage and overall national development, because optimal KM in organisations is the foundation of a knowledge-based economy. The basic idea is to strengthen, improve and propel the organisation by using the wealth of information and knowledge that the organization and its members possess (Milton, 2003).

Malhotra (1998) asserts that KM is critical for organisational adaptation, survival and competitiveness during discontinuous environmental change. Essentially, it embodies organisational processes that seek synergistic combination of data and information processing capacity of information technologies and the creative and innovative capacity of human beings. According to Saffady (2000), KM is concerned with the systematic, effective management and utilisation of organisation resources. Tsoukas and Vladmirou (2001) stress that KM is the dynamic processes of turning an unreflective practice into a reflective one, by elucidating the rules guiding the activities of the practice and by helping to give a particular shape to collective understanding. KM is a process which, when followed and applied, could lead to the success of organisations such as the Nigerian agricultural research institutes. For example, Call (2005) explains that successful KM gives you access to the information you need to do your job better than you did in the past. KM does not provide you with the answers to your problems rather it facilitates the learning of the answer, hence the need for KM strategies and practices in organisations like the Nigerian agricultural research institutes, for increased productivity and efficient service delivery.

Today, capital accumulation has become more knowledge-based and knowledge-intensive; those countries, firms and individuals that have access to the most sophisticated knowledge and information are able to compete (Gill, 1996). Available knowledge at individual and collective levels has to be optimally managed and developed. After human resource management, KM is now an important field within business administration and information technology (Davenport and Pruska 1998; Leonard-Barton, 1995). Much of the overall spending by firms on KM initiatives is driven by strategic imperatives that depend on the effective management of the knowledge resources (Lee and Sukoco, 2007). One of the main reasons firms invest in KM is to build a knowledge capability that facilitates the management and flow of information and knowledge within the firm. Therefore the above postulations by Drucker, 1993; Neef, 1999; Morrow, 2001; Barclay, 2000; Zack, 1991; Nonaka, 1991; Ruggles and Holthouse, 1999; Bell and Jackson, 2001; Ronald, 2004; Quintas *et al.,* 1997; Birkinshaw and Sheehan 2002; Tidd *et al.,* 2001; Metcalfe, 2005; Milton, 2003; Malhotra, 1998; Saffady, 2000; Tsoukas and Vladmirou, 2001; Call, 2005; Gill, 1996; Davenport and Prusak, 1998; Leonard-Barton, 1995; and Lee and Sukoco 2007 had provided a context and justification for the present study, set out to investigate the KM strategies and practices in Nigerian agricultural research institutes.

1.2 Global perspective of knowledge management in agriculture

At global level, a search of the literature (using the string KM strategies and practices in agriculture) returned 10 691 results from AGRICOLA, AGRIS, and Science Direct databases. From the results obtained, most of the studies seem concentrated in Asia (Payumo, 2011); Latin America (Isabel, 2007); and Europe (Igram, 2008), respectively, covering such countries as China (Yuanmei *et al.,* 2011; Aree, 2011); Japan (Zakaria and Nagata 2010); Indonesia (Suhermanto, 2002); Kumaon Himalayas (Honwad, 2010); India (Agriculture Week, 2012); Cuba (Carrasco, 2003); El Salvador (Michmerhuizen, 1997); Brazil (Marcello *et al.,* 2013); England (Ingram, 2008); Uzbekistan (Turaeva and Hornidge, 2013; Sabetghadam, 2003); and Serbia (Njegovan et al., 2011). These studies focused on topics such as: indigenous ecological KM in China; agronomist-farmer KM in England; analysis of the implications of intellectual output in agriculture for developing countries with reference to Southeast Asia; knowledge creation and flow in agriculture, the Japanese experience; regional development through knowledge creation in organic agriculture in Latin America; role of extension services in the Cuban agricultural knowledge and information systems; knowledge and information transfer in the agricultural sector of Indonesia; research management at the Brazilian agricultural corporation's use of indigenous knowledge in environmental decision-making by communities in the Kumaon Himalayas; relational knowledge systems and their impact on management of mountains ecosystems in Latin America; local farmer knowledge and management practices for preferred species of an indigenous agroforestry system in El Salvador; agricultural knowledge development - investing in people (human capital) in Serbia; knowledge of agricultural science in Indian research institutes; agricultural innovations and their diffusion in Uzbekistan; and indigenous knowledge - implications for the theory and practice of agricultural education and extension in Latin America.

Within the African context, a search of agricultural databases using the stream *knowledge management strategies and practices in agriculture* returned the following disaggregated results by database: AGRICOLA (8,934), AGRIS (8,940), and CAB ABSTRACTS (2,744). These studies were carried out in Tanzania (Edda *et al.,* 2010; Edda, 2011); Guinea-Bissau (Marina, 2011); Egypt (Soliman, 2003); Ethiopia (Assefa *et al.,* 2011); Sierra Leone (Tarlton, 1994); Ghana (Addom, 2010; Dawoe *et al.,* 2012); Zimbabwe (Muchena,1990); Somalia (Ulusso, 1990); Kenya (Hilda and Stilwell, 2013); and South Africa (Dweba and Mearns, 2011; Ndoro, 2011). The following topics were covered by these studies: managing indigenous knowledge for sustainable agricultural development in developing countries - case study of Tanzania; role of the public and knowledge management as determinants of environmental policy formulation in developing countries-case of Egypt; planting knowledge, harvesting biodiversity-a case study of Guinea-Bissau rice farming; agricultural KM in dairy production improvement in Amhara region of Ethiopia; KM approaches in managing agricultural indigenous and exogenous knowledge in Tanzania; knowledge brokering in the digital age-case of agricultural innovation systems in Ghana; bureaucratic barriers and constraints to the utilisation of indigenous knowledge in sustainable agriculture in Sierra-Leone; analysis of indigenous knowledge system-implications for agricultural extension education in Zimbabwe; conserving indigenous knowledge as the key to the current and future use of traditional vegetables in a Xhosa village of the Eastern Cape, South Africa; exploring farmers' local knowledge and perceptions of soil fertility and management in the Ashanti region of Ghana; agricultural knowledge systems of small-scale farmers in Africa, with reference to Kenya; and analysis of the agricultural knowledge system of Somalia.

In practice, the effort by the Global Agricultural Research Archive (GARA) to digitally capture research and create a knowledge archive on behalf of three developing countries in Africa, South Asia, and South East Asia, namely Malawi, Pakistan and the Philippines, was a step in the right direction for the sustainable agricultural knowledge development in participating countries and beyond. This is already a vital resource within these countries, as well as offering the potential for creating an important network that could be shared across the region. The archive is centrally managed and maintained to enable preservation, disaster recovery and a long-term protection of knowledge which might otherwise became inaccessible, as improving access will liberalise agricultural knowledge. When research succeeds and outputs are documented, disseminated and preserved, this could increase productivity, just as a small team of researchers has the ability to raise the productivity and income of millions of farmers (CABI, 20014).

1.2.1 Historical development of Nigerian agricultural research

Nigeria is the most populous country in Africa, with an estimated population of 174 507 537 million people (CIA World FactBook, 2014) and accounts for 41 percent of West Africa's population. Nigeria is geographically located on the coast of western Africa. It covers an area of about 924,000 km^2 and is bordered to the north by the Niger Republic, to the east by Chad and Cameroun, on the south by the Gulf of Guinea and to the west by the Republic of Benin (Encyclopedia Britannica, 2002). It practises a federal system of government, with three tiers of government. This consists of a federal government, with a federal capital territory located in Abuja and headed by the President. There are 36 state governments, each headed by a Governor, and 774 local government areas, headed by a Chairman/Chairperson (Nigeria Country Profile, 2009). In recent times the 36 states of Nigeria have been divided into six geo-political zones namely: South-South, South-West, South-East, North-West, North-East and North-Central (Olaleye and Akanbi, 2009). Although these zones are not contained in the Nigerian constitution, they form the basis for many of permutations that take place in political circles, especially in areas of political appointment, locating of federal projects and other forms of federal character compliance.

Agricultural research provides information for policy-makers and funding agencies. It provides transfer of research-induced technology to farmers, which is the only way to measure research benefits to society. An agricultural research impact study provides feedback to scientists on which technologies or technology components are successful at farm level (Adenike, 2011) cited in Uganneya *et al.* (2013). There are three major agro-ecological zones in Nigeria: the dry savannah, with a length of growing period (LGP) of less than 150 days, the moist savannah with a LGP of 150–270 days, and the humid forest, with LGP greater than 270 days (Jagtap, 1995). Agricultural research in Nigeria started more than 100 years ago, with the establishment of a botanical garden in Lagos, during the late 19^{th} century. By 1903, the Forestry and Botanical Department (renamed Agricultural Department) for Southern Nigeria was created. By 1912, the latter was divided into Northern and Southern regions. By 1914, the Forestry and Veterinary Departments were created. The Fishery Department evolved in 1951. In a nutshell, by the 1970s and 1980s, different research institutes and departments of agriculture had emerged. At present, Nigeria has the largest and most elaborate national agricultural research system in Sub-Saharan Africa. By 2006, the government set up an umbrella body known as the Agricultural Research Council of Nigeria (ARCN), which was established to address the challenges faced by agricultural research. The ARCN's mission is to achieve significant improvement in agricultural productivity, marketing and competitiveness, through the generation of appropriate technologies, policy options and KM of the agricultural research system. ARCN is able to achieve their mission through the adopted village studies and the Agricultural Research Outreach Centres (AROC).

1.2.2 Development and mandates of the five Nigerian agricultural research institutes

This section briefly traces the historical development and mandates of the five agricultural research institutes under study.

1.2.2.1 Institute for Agricultural Research (IAR) Zaria

The Institute for Agricultural Research, Samaru-Zaria, was established in 1924 as the research division of the Department of Agriculture for the then Northern Province of Nigeria. IAR was formally transferred by law to the newly established Ahmadu Bello University on October 14, 1962. With the federalization of the University in 1975, the IAR was established in accordance with statute 14 of the University. Since its establishment, IAR has been the bed-rock of crop research and improvement in the savannah region of Nigeria.

The institute has three research outstation namely; Agricultural Research Station (ARS) Kano, in Kano state, Irrigation Research Station (IRS) Kadawa, Kano State, and Irrigation Research Station, Talata Mafara, Zamfara State (Institute for Agricultural Research, 2014)

By April 1980, following the reorganisation of National Research Systems in the country, IAR was mandated to conduct research on:

a- Genetic improvement of sorghum, cowpea, groundnut, cotton, sunflower and, later, maize castor, artemisia and jatropha.

b- Problems of all agricultural food crops production in the North-West agro-ecological zone covering Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara states. In particular, the Institute is to address problems of:

   i. Crop agronomy, including cultivation, planting and harvesting
   ii. Adaptation of introduced and improved crop varieties/cultivars
   iii. Development and testing of pest and disease control measures
   iv. Farming systems, including integration of three crops, livestock and agro forestry in to production systems
   v. Socio-economic problems of agricultural production, soil fertility and soil stabilization
   vi. The production of irrigated crops
   vii. Simple preservation, storage and processing in the rural setting of the crops listed in (a) above
   viii. Design and fabrication of simple agricultural implements and equipment

c- Carry out agricultural extension liaison with relevant federal and states ministries, primary agricultural producers, industries and any other users of research results within the zone, in collaboration with NAERLS
d- Organise technical and vocational courses in agricultural crop production and related fields within the zone
e- Provide laboratory and other services to farmers, agro-based industries and others needing these services
f- Collaborate with all other relevant research institutes and organiaations

1.2.2.2 Institute for Agricultural Research and Training, Ibadan

This Institute is one of the foremost agricultural research centres in Nigeria. Its affiliation with the then University of Ife (now Obafemi Awolowo University, Ile-Ife) in 1969 makes it one of the four university-based agricultural research institutes in Nigeria. Even though this affiliation opens many opportunities to the Institute, it also bestows responsibilities and challenges to the entire workforce. The Institute is in intimate contact with resource-poor farmers throughout the nooks and crannies of South-Western Nigeria, covering the eight states of Lagos, Ogun, Oyo, Osun, Ondo, Ekiti, Edo and Delta states. As the south-west zonal co-ordinating research institute, demand-driven, peasant-farmer targeted, improved agricultural technologies are generated and disseminated to thousands of farmer families in the zone and beyond. The Institute has developed over the years, outstanding varieties of many common staples, including maize, cowpea, cassava, fruit and leaf vegetables. The mandate of the Institute includes (Institute of Agricultural Research and Training, 2014):

a- Soil and water management research
b- Genetic improvement of kenaf and jute
c- Genetic improvement of maize for the forest and humid savannah agro-ecologies in Southern Nigeria
d- Farming systems research and extension in the south-west zone
e- Joint national co-ordinator for the Nationally Co-ordinated Research Project (NCRP) on soybeans and livestock research, with particular reference to small ruminants (goats and sheep) pigs and poultry

f- Genetic improvement of legumes adaptable to the forest and humid savannah of south-west Nigeria.

1.2.2.3 National Root Crops Research Institute, Umudike

The NRCRI is one of the prominent agricultural research institutes in Nigeria. The institute started as a provincial experiment farm under the Nigerian Department of Agriculture with headquarters at Moor Plantation, Ibadan on January 1, 1923. In 1955, the training arm, the School of Agriculture, was established and the two establishments came under the Director of Agriculture, with headquarters at Enugu, following the regionalisation of the country. They were known as the Eastern Nigeria Agricultural Research Station. The institute was merged with the School of Agriculture and became the Agricultural Research and Training Station (ARTS) in 1956. It assumed a federal status, to become the Federal Agricultural Research and Training Station, (FARTS) on April 1, 1972.

By April 1, 1976, was re-named National Root Crops Research Institute by the Agricultural Research Institutes Decree of 1973, and its enabling Acts of 1975, and fell under the Agricultural Research Council of Nigeria (ARCN).

In line with its national and zonal mandates, the Institute has the responsibility of conducting research into (National Root Crops Research Institute, Umudike 2014) :

i. General improvement of root and tuber crops of economic importance in Nigeria, such as cassava, yam, sweet potato, Irish potato, ginger, rizga, Hausa potato, sugar beets and turmeric
ii. Agronomy of root and tuber crop production, including farming systems development for the South-East agro-ecology
iii. Socio-economic problems related to root and tuber crop production
iv. Storage, processing and utilisation of root and tuber crops
v. Design and fabrication of simple agricultural farm tools and equipment
vi. The National Root Crops Research Institute has the zonal mandate for the total farming systems research and extension covering the states of the South-East, namely: Abia, Akwa Ibom, Anambra, Bayelsa, Cross-Rivers, Ebonyi, Enugu, Imo and Rivers. It carries

out agricultural extension and liaison with relevant federal and states ministries, primary agricultural producers, industries and other users of research findings in collaboration with the National Agricultural Extension and Liaison Services (NAELS).

vii. Training middle level manpower in agriculture, leading to the award of Ordinary National Diploma/Higher National Diploma, including vocational training for farmers on specialised topics.

1.2.2.4 National Cereals Research Institute, Badeggi

The NCRI is a Nigerian agricultural research centre with station headquarters in Badeggi, Niger state, and a research focus on the Middle Belt (North-Central) region of Nigeria. It was established in 1975 as a successor to the Federal Agricultural Research Station or Federal Department of Agricultural Food and Soil Research Unit, which had been in existence since 1898, when it was a research division established by Alfred Malomy. The mandate of the Institute is to conduct research on genetic improvement of various food crops such as maize, sugarcane, cowpea, soya beans, beniseed and other legumes and to conduct research on pasture agronomy, soil fertility, agricultural mechanization, economics and statistics (National Cereals Research Institute, Badeggi, 2014).

1.2.2.5 Lake Chad Research Institute, Maiduguri

The LCRI was established by the Federal Government of Nigeria in 1975, with its headquarters in Maiduguri, Borno State. The research institute mandate cover states in the North-Eastern part of the country (namely Borno, Yobe, Adamawa, Taraba, Bauchi and Gombe States), in the following fields (Lake Chad Research Institute, Maiduguri, 2014).

i- Hydrological behaviour and characteristics of the Lake Chad and limnological status of the associated surface and ground water

ii- The abundance, distribution and other biological characteristics of species of fish and aquatic forms of life in the Lake and practical methods of their rational exploitation iii- The behaviour and characteristics of the wild fauna and flora associated with the Lake and their conservation

iv- The ecology and method of control of crops, pests and diseases of economic importance

v- The improvement of the method of control of dry farming and livestock husbandry in the severe environmental conditions around the Lake

vi- The improvement of the cultivation of weeds, valley and other crops by irrigation around the Lake

vii- Lastly, the Institute is mandated to compile, interpret and disseminate the research results of the Institute to end-users

1.2.3 Description of the study area

The target population of this study consists of all the 17 agricultural research institutes in Nigeria. Out of the 17, five research institutes were selected from the five geopolitical zones. Each zone has one major agro-based research institute (A.R.C.N., 2008). The locations of the five institutes are depicted in the map of Nigeria, shown in Figure 1.1.

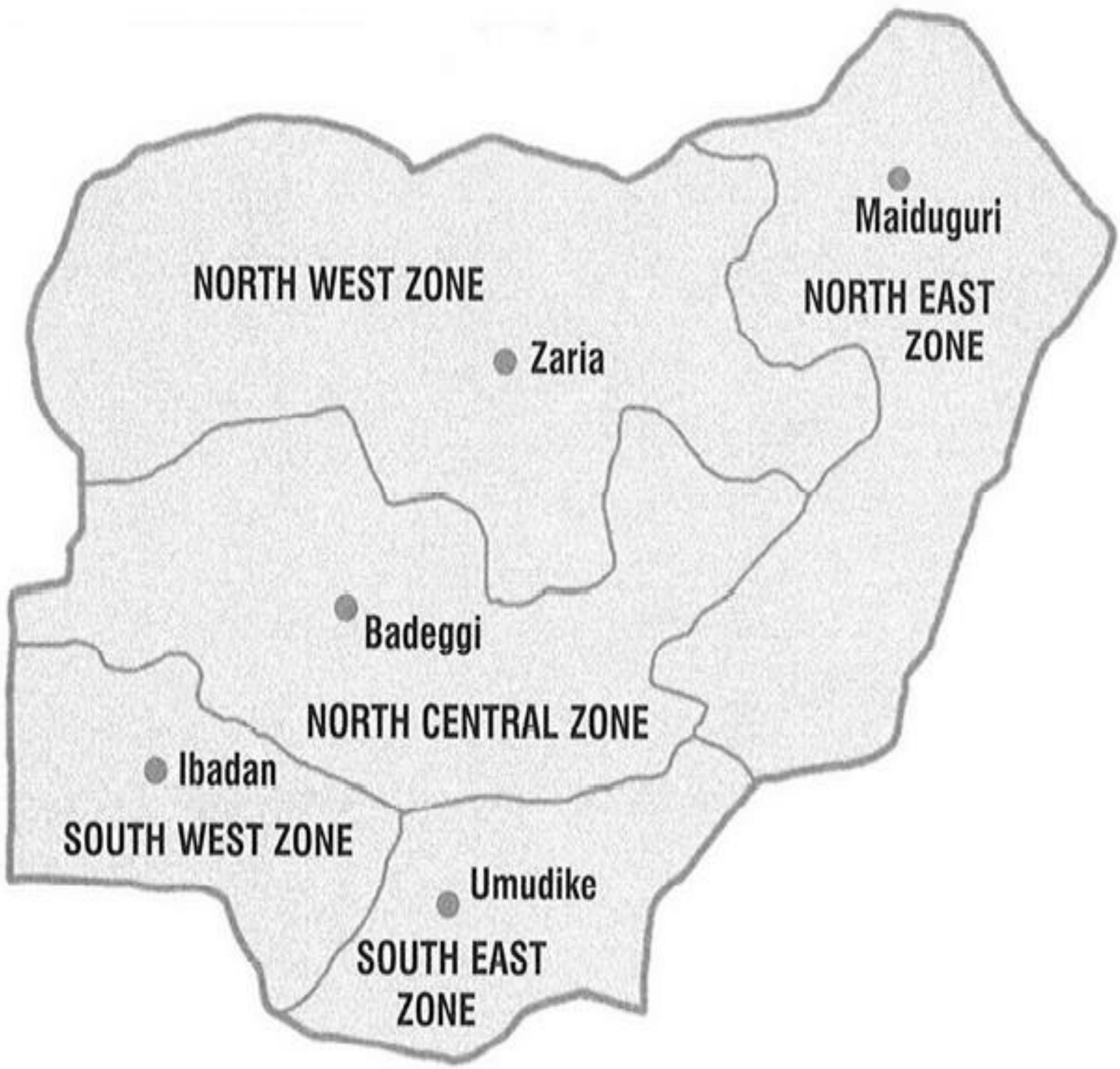

Figure 1.1 Map of Nigeria, showing the locations of the present study.

The five institutes covered by the present study serve as zonal agricultural research co-ordinating institutes for all the states within the respective zones. The research institutes and states covered include (A.R.C.N, 2008):

1. National Root Crops Research Institute (NRCRI), Umudike, Abia State (South-East) covering Abia, Akwa Ibom, Anambra, Bayelsa, Cross-Rivers, Ebonyi, Enugu, Imo and Rivers States.
2. Institute for Agricultural Research and Training (IAR&T) Ibadan, Oyo State (South-West) covering Ogun, Oyo, Osun, Ondo, Ekiti, Lagos, Edo and Delta States.

3. National Cereals Research Institute, Badeggi, Niger State (North-Central) covering Niger, Abuja FCT, Kwara, Kogi and Benue States.
4. Institute for Agricultural Research (IAR) Zaria, Kaduna State (North-West) covering Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara States.
5. Lake Chad Research Institute (LCRI), Maiduguri, Borno State (North-East) covering Gombe, Bauchi, Taraba, Adamawa, Yobe and Borno States.

Zaria, Badeggi, Ibadan, Umudike and Maiduguri institutes are in different zones (geo-political zones) of the country, hence, the generalization concerning the state of KM in the Nigerian agricultural research institutes.

1.3 Statement of the problem

The knowledge economy is driven by knowledge capital. As today's economy becomes more knowledge and information driven, so does the necessity for effective information and knowledge management strategies in all organisations. KM brings together three core organisational resources - people, processes and technologies-to enable the organisation to use and share information (Milton, 2003). KM, if properly implemented, and made an integral part of an organisation, can help in saving valuable time wasted in seeking information needed to address socio-economic and development problems (Alvesson and Karreman, 2001).

During the 1950s, 1960s and early 1970s, agriculture was the mainstay of the Nigerian economy and contributed over 94% of government revenue and 60-70% of total exports (Daramola *et al.,* 2008). Since the discovery of Nigerian oil in the 1970s, agriculture's significance has declined and oil now totals 95% of exports and 40% of government revenues (EIA, 2012). At present, agriculture only accounts for 0.2% of exports (Daramola *et al.,* 2008). Declining agricultural production arising from total dependence on crude oil exports as a means of growing the economy has relegated the role played by the agricultural research institutes in innovation development and knowledge discovery, which is now characterised by a myriad of problems such as poor knowledge management infrastructure, capacity building (i.e. requisite skills and expertise), declining research culture, poor staff motivation, inadequate government support and a perennially declining research budget. This is evident in the nation's agricultural sector contribution to the GDP, which was down to 30.9% in the year 2013. In contrast, the industrial sector contributed 43% (CIA World FactBook, 2014). Nigeria is therefore increasingly becoming dependent on food imports to feed the rapidly growing population of 174 507 537 million people (CIA World FactBook, 2014). The importance of KM in enhancing agricultural production in a country like Nigeria, with a very high population, need not be over-emphasised.

According to Shehu (2013) Nigeria spends 16.7% of GDP (N1.3 trillion) on food imports. This trend is not sustainable. Nigeria must become self-sufficient in feeding its own people by investing in the agricultural sector. The agricultural research institutes in this regard are vital to drive research and innovation in agriculture. KM is a critical tool in innovation, research and development. The resultant effect of these problems in the context of this study is: i) poor agricultural research and development in the country; ii) low productivity and income in the sector; iii) inadequate farmers' skills and innovations for enhanced output; iv) declined government revenue impeding national development; and v) high importation of food and other agricultural products.

1.4 Objectives of the study

The main objective of this study was to investigate KM strategies and practices in Nigerian agricultural research institutes. The main objective of the study was subdivided into specific objectives, as follows:

1.4.1 Identify the type of knowledge generated by the Nigerian agricultural research institutes.

1.4.2 Establish the extent of knowledge production by the research institutes.

1.4.3 Identify KM strategies used by the research institutes to derive research and innovation.

1.4.4 Determine how the knowledge generated is disseminated.

1.4.5 Identify KM infrastructure available in the research institutes.

1.4.6 Investigate factors influencing KM adoption in the research institutes.

1.5 Research questions

The study addressed the following research questions;

1.5.1 What type of knowledge is generated by the Nigerian agricultural research institutes?

1.5.2 What is the extent of knowledge production by the research institutes?

1.5.3 What KM strategies are used in the research institutes to derive research and innovation?

1.5.4 How is the knowledge generated disseminated?

1.5.5 What KM infrastructure is available to the research institutes?

1.5.6 What factors influence KM adoption in the research institutes?

1.6 Delimitation of the study

This study focuses on knowledge management strategies and practices phenomenon in Nigerian agricultural research institutes. The study involved the institutes' research scientists, directors and heads of information and documentation units for data collection, to actualise its objectives.

The study involved five major agricultural research institutes spread across the five geo-political zones of Nigeria: Institute for Agricultural Research (I.A.R.) Zaria; Institute for Agricultural Research and Training (I.A.R. & T.) Ibadan; National Root Crops Research Institutes (N.R.C.R.I.) Umudike; National Cereals Research Institute (N.C.R.I.) Badeggi; and Lake Chad Research Institute (L.C.R.I.) Maiduguri. Based on this, other Nigerian agricultural research institutes (as indicated in section 4.5) are not involved in the present study. During the study, the following challenges were prominent:

1. The busy nature of the research scientists made it very difficult for the researcher to retrieve the survey instruments distributed to them, because many are engaged in one research or another and mostly outside the states where the institutes are located.
2. The tight schedule of two of the directors made it impossible to track them down for interviews, as they preferred to collect the semi-structured interview schedule, complete it at home and return it to the researcher. The director of the National Cereals Research Institute (N.C.R.I.) Badeggi could not be reached for interviews throughout the period of the study, due to what was described at the Institute as a perennial power struggle between the director and the staff union of the Institute. None of his deputies was willing to act on

his behalf because of fear of the unknown. This scenario was the same for the head of the information and documentation unit of the Lake Chad Research Institute (L.C.R.I.) Maiduguri, where the researcher could not hold interviews with her. A source at the Institute revealed that most of the staff do not come to the office due to the security situation (Boko Haram Insurgency) in Maiduguri and the inability of the government to pay their salaries for three months.

3. Some of the survey respondents were hesitant to respond to some of the questions on the questionnaire for reasons best known to them, thereby leaving such questions unanswered.

4. The challenges regarding the delays in retrieving the survey questionnaire culminated in the researcher (after spending 4-6 days in a particular institute) employing research assistants to help in retrieving the remaining questionnaire and sending it to the researcher via registered mail. Finally, the research institutes surveyed represented a fair selection of Nigerian agricultural research institutes and provided what is seen to be a picture of the KM activities in the Nigerian agricultural research institutes, based on the fact that these institutes are the major ones and represent their respective zones.

1.7 Definition of key terms

This section provides the operational definitions of key terms as they are used in the context of the present study. They include: knowledge, knowledge management, intellectual capital, agricultural research institutes, tacit knowledge, explicit knowledge, knowledge worker, knowledge management strategy.

1.7.1 Knowledge

Knowledge is defined as an ordered set of information in space and time about important notions, data, facts, axioms, laws and inference rules related to a specified field of human experience, embedded in a given thought-framework (Roska, 2003). It follows that information without a thought-framework will not be qualified as knowledge. An atomic (elementary) piece of knowledge is sometimes called a “knowledge unit”. The latter is similar to the term “knowledge” in that it also has many characteristics and more or less an exact definition. For example, Zack (1999a) says that “a knowledge unit is an atomic packet of knowledge content that can be labelled, indexed, stored, retrieved and manipulated". Knowledge is a fluid mix of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms (Davenport and Prusak, 2000).

1.7.2 Knowledge management (KM)

KM is the set of captured, stored and shared information of the products, processes and people in organisations that enhance the overall productivity of the system. KM also represents an ongoing relationship between and among people, processes and technology systems involved in designing, capturing and implementing the intellectual infrastructure of an organisation. It encompasses essential changes in management attitudes, organisational behavior, culture and policies. According to Koenig (2012), KM is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving and sharing all information assets. These assets may include databases, documents, policies, procedures and previously un-captured expertise and experience in an individual. With the help of such KM, one can gain better understanding, sharing and utilisation of existing knowledge, thereby attaining a competitive advantage by organisations. All of the KM activities result in documentation of the knowledge in the form of a centrally available repository.

1.7.3 Intellectual capital (IC)

IC is defined as intangible assets which include technology, employed information, brand names, reputations and corporate culture that are invaluable to a firm's competitive power (Low and Kalafut, 2002). IC consists of: (1) tacit knowledge and innovativeness of the employees; (2) infrastructure of human capital (i.e. good working systems, innovation) and improved processes of structural capital and; (3) external relationships of the firm (i.e. employees' capital). These are the key drivers of an organisation's performance and creation of future wealth (Bontis *et al.,* 2000; Riahi-Belkaoui, 2003).

1.7.4 Tacit knowledge

This means knowledge held by individuals, known as knowledge of the mind. It is based on intuition, experience, skills, beliefs and mental models. According to Nonaka and Takeuchi (1995), classification of knowledge and tacit knowledge are highly personal and hard to formalise, making them difficult to communicate or to share with others, such as subjective insights, intuitions and hunches, which are deeply rooted in an individual's action and experience, as well as in the ideals, values, or emotions he or she embraces. According to them, tacit knowledge can be segmented into two dimensions. The first, the technical dimension, encompasses the kind of informal and hard-to-pin-down skills or crafts captured in the term "know-how". The second is a cognitive dimension which consists of schemata, mental models, beliefs and perceptions so ingrained that we take them for granted. The cognitive dimension of tacit knowledge reflects our image of reality (what is) and our vision for the future (what ought to be) (Nonaka and Takeuchi, 1995).

1.7.5 Explicit knowledge

This is knowledge that can be articulated and communicated and is known as codified knowledge. It is a knowledge found in documents, databases, manuals, blueprints and other repositories. According to Nonaka and Takeuchi (1995), explicit knowledge can be expressed in words and numbers and easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles.

1.7.6 Knowledge workers

Knowledge managers and knowledge workers comprise the entire spectrum of KM-related positions. They may include such titles/roles as Chief Knowledge Officer (CKO), knowledge broker (Dalkir, 2005: 34), knowledge analyst (Skyrme, 2011c) or knowledge systems engineer (Civilian Career Path Guide, 2002: 37). The following broad categories of skills are required for knowledge workers (KM Skills Map, 2000): strategic and business skills; management skills; intellectual and learning skills; communication and interpersonal skills; information management skills; and IT skills

1.7.7 Agricultural research institutes

Agricultural research institutes can be seen as governmental and non-governmental organisations engaged in research into agriculture, the environment, biodiversity and the nature of the discovery of hitherto unknown innovations and solutions for the development of agriculture in terms of food security, livestock production, revenue enhancement, farming systems development, farm implements and equipment, and the general well-being of humanity. Agricultural research has the potential to be the industrial and economic springboard from which a country’s development can take off. It also has the potential to shape the landscape, provide environmental benefits, such as land conservation, guarantee the sustainable management of renewable natural resources, preserve biodiversity and contribute to the viability of many rural areas (Humbert, 2000). In fact, through its different spheres of activities at both the macro and micro levels, the agricultural sector is strategically positioned to have a high multiplier effect on any nation's quest for socio-economic and industrial development (Ogen, 2007).

1.7.8 Knowledge management strategies

Knowledge management strategies can be seen as techniques used to derive competitive advantage from the control and co-ordination of organisational knowledge flows, because knowledge flows help in transmitting localised know-how, which is generated in one subunit to other locations in the organisation, and also facilitates the co-ordination of work flows linking multiple, geographically dispersed, subunits. Developing a KM strategy is important in effective KM activities in organisations. An appropriate KM strategy enables a firm to create, acquire, access and leverage knowledge in a timely manner, resulting in better performance (Gray and Meister, 2004). There are two types of KM strategies: system strategy, known as codification strategy; and human strategy, also called personalisation strategy (Leiponen, 2006; Zahra and Neilsen, 2002).

1.8 Significance of the study

The study is significant in terms of the following:

Policy- serves as a basis for re-evaluation, re-focusing and re-strategising KM activities through the provision of clear policy direction and implementation strategies for a robust intellectual asset management in Nigerian agricultural research institutes.

Practice- provides an impetus for the improvement of KM practices, thereby ensuring effective service delivery to the stakeholders such as farmers, collaborators, non-governmental organizations and governments at different levels.

Theory- making contribution to the domain body of literature/knowledge and providing awareness of the KM strategies and practices in the institutes and in Nigeria as a whole.

Society- findings and recommendations which benefit the society through improved farming systems and innovation development, thereby attaining food security and an enhanced revenue base for the country.

1.9 Summary

Chapter One provided the context of the study, by discussing the role and necessity for the management of intellectual capital or knowledge in organisations for increased productivity and attainment of competitive advantage, global perspectives of knowledge management in agriculture, the historical development of the Nigerian agricultural research, development and mandates of the five institutes under study, statement of the problem, description of the study area, objectives of the study, research questions, delimitation of the study, definition of key terms used in the study, significance of the study and a table mapping the principal theory variables with the research questions and research objectives. A key issue that emerged in this chapter is that knowledge management is a universal language and practice which no organisation, either private or public, can afford to abandon and relegate to the background. This is evident in the paradigm shift from production or industrial-based to service-based economy, reliant on skilled professionals and sophisticated technologies currently witnessed in the world (Neef, 1999).

CHAPTER TWO

THEORETICAL FRAMEWORK

2.1 Introduction

A theoretical framework is a general theoretical system with assumptions, concepts and specific social theories (Neuman, 2006). Brink and Rensburg (2012) assert that a theoretical framework is based on propositional statements resulting from an existing theory. Theories are formulated to explain, predict and understand a phenomenon and, in many cases, to challenge and extend existing knowledge within the limits of the critical bounding assumptions. According to Asher (1984), a theoretical framework is the structure that can hold or support a theory of a study. It introduces and describes the theory, which explains why the research problem under study exists. A theoretical framework consists of concepts, together with their definitions, and existing theory/theories that are used for a particular study.

A theory, according to Creswell (2009), is defined as an interrelated set of constructs (variables), formed as propositions or hypotheses that specify the relationship among variables. Therefore theory provides an orientation to the research study and positions the researcher in the discipline or subject to reflect the research goals (Henning, Rensburg and Smit, 2004). The purpose of theories is to make research findings meaningful and generalisable. They help to stimulate research and the extension of knowledge by providing both direction and impetus (Polit and Beck, 2004). Theory is a set of interrelated constructs (variables), statements, definitions and propositions that present a systemic view of a phenomenon by specifying relations among variables, with the purpose of explaining a natural phenomenon (Kerlinger 1973; Welman, Kruger and Mitchell, 2010). Therefore, theory strengthens a study in the following ways (Williams, 2006:274):

- Permits the reader to evaluate assumptions critically
- Connects the researcher to existing knowledge. Guided by a relevant theory, a researcher is given a basis for his/her hypotheses and choice of research methods
- Forces a researcher to address questions of why and how. It permits a researcher to move from simply describing a phenomenon observed to generalising about various aspects of that phenomenon

- Helps the researcher to identify the limits of generalisations. A theory specifies which key variables influence a phenomenon of interest. It alerts the researcher to examine how those key variables might differ and in what circumstances.

The main theme of this study was to investigate the knowledge management strategies and practices in Nigerian agricultural research institutes. The study reviews the following theoretical frames: Nonaka and Takeuchi (1995) Knowledge-Creating theory; Boisot (1987) Knowledge Category Model; Grant (1996) Knowledge-Based View of the firm; Conner and Prahalad (1996) Resource-Based View; Sanchez (2001a) Competence-Based View; Ginsberg (1994) Cognitive-Frameworks theory; and Teece *et al.* (1997) Capability Perspective theory.

The organisation of this chapter is informed by those of Creswell (1994), on how the theoretical framework chapter should be presented. According to Creswell (1994), the theoretical framework should be separated from the literature section because the theoretical frame is a structure that presents the theory which explain why the problem under study exists, hence it should be organized to cover all the major variables of a study. He explains that the framework demonstrates the relationships between the issues and reviewed literature on independent and dependent variables and on scholarly literature that relates to the dependent and independent variables. The present researcher begins the study by advancing a theory. He collects data to test it, and reflects on whether the theory was confirmed or disconfirmed by the results of the study. The theory becomes a framework for the entire study, an organising model for the research questions or hypotheses for the data collection procedure (Creswell, 1994). Chapter Two is therefore divided into a number of sections. Section 2.1 introduces the chapter. Section 2.2 discusses the Knowledge-Based View of the firm and Section 2.3 elaborates on the Resource-Based View (RBV). Section 2.4 describes the Competence-Based View and Section 2.5 discusses the Cognitive Framework Theory. Section 2.6 describes the Knowledge Category Model, while Section 2.7 elaborates on the Capability Perspective Theory. Section 2.8 discusses the Knowledge-Creating Theory and justification for its choice as the main theoretical frame for this study, while Section 2.9 summarises the entire theoretical frames, on the basis of aspect covered, weaknesses and strength in the context of the present study.

These theories have been used in studies of knowledge management within the disciplines of economics, management, business administration, marketing, agriculture, information science, and organizational learning (Literature Review, 2014).

2.2 Knowledge-based view

This theory is based on certain premises regarding the nature of knowledge and its role within the firm; it explains the rationale for the firm, the delineation of its boundaries, the nature of organisational capability, the distribution of decision-making authority and the determinants of strategic alliances. The knowledge-based view represents a confluence of a number of streams of research, the most prominent being the resource-based theory and 'epistemology' (the work of Micheal Polanyi exerting a particular influence). The knowledge-based view of the firm (e.g. Grant, 1996; Conner and Prahalad, 1996; Spender, 1996) is strategic in its orientation, focusing on the mechanisms that drive the relative performance and competitive advantage. It rests intellectually on the ideas of the resource-based view (Barney, 1991; Peteraf, 1993; Amit and Schoemaker, 1993) which focuses explicitly on knowledge as the ultimate resource for the firm's performance and attainment of competitive advantage. Contributing literature to this theory include 'organisational learning' (e.g. March, 1962; Argyris, 1993), 'organisational capabilities and competence' (Prahalad and Hamel, 1990, as cited in Grant 1997), and 'innovation and new product development' (e.g. Teece, 1996; Clark and Fujimoto, 1991). Pioneers of the emerging knowledge-based view include Kogut and Zander (1992), Nonaka (1994), Hedlund (1994), von Krogh and Roos (1996) and Spender (1996a) (Literature Review, 2014).

In 1996, Grant and Spender started their journey into the knowledge-based field of the firm, with ''Knowledge and the Firm.'' Here they introduced two different conceptual directions; an economic and a social-constructionist one (e.g. Grant, 1996; Grant and Spender, 1996; Spender, 1996b). Grant's interest came from industrial economics, inspired by positivist philosophy, which led him to work on an extension of the resource-based approach of the firm. In contrast, Spender called for a radical change 'towards a social constructionist position which focuses on the dynamics of the individual's institutional context' (Spender, 1996a). The departure from the positivist paradigm was novel and daring at the time within strategic management, although the movement was already well under way in other social science disciplines (e.g. see Berger and

Luckmann, 1967; Marcus and Clifford, 1986). Spender suggested that knowledge should be regarded as embedded within socio-cultural conventions and conceptualisations and thus as socio-culturally construed (e.g. Astley, 1985; Mir and Watson, 2000; Scherer and Dowling, 1995).

Consequently, within the strategy field, Spender emerged as one of the pioneers of the social constructionist position (Spender, 1989; Spender, 1993, 1994, 1995, 1996, 1998, 2000, 2001). Arguably, the most influential aspect of Spender's work is his view of the firm as a congregation of pluralist knowledge systems in which practices and routines interact with tacit knowledge constructs (e.g. Inkpen and Dinur, 1998; Lam, 2000; Malan and Kriger, 1998; Robertson and Swan, 1998). Spender's conceptualisation of a social-constructionist knowledge-based view of the firm includes the following core assumptions: (1) The firm can be understood as a system of knowledge; (2) explicit and implicit knowing are clearly dissociated; (3) firms are conceived as cognising entities (i.e. having a collective consciousness); and (4) intuition, shaped by shared cultural practices, is a superior source of managerial knowledge. The central feature of the knowledge-based view is the notion of 'tacitness' (Grant, 1996), because tacit knowledge is a potential source of competitive advantage due to its limited transferability. Although the knowledge-based view clearly suggests that knowledge can be a source of sustained competitive advantage, it is relatively unclear about the ways in which knowledge is utilised in order to contribute to the attainment of the competitive advantage. For instance, Spender (1996) says 'it is the performance, especially in the face of unanticipated uncertainties and challenges that is the true test of executive knowledge'. However, the four key managerial heuristics proposed by Spender (interpretive flexibility, boundary management, identification of institutional influences, distinguishing between systemic and component features) do not say much about the issues associated with the materialisation of knowledge, but rather about how new knowledge is created and organised. Correspondingly, Grant's (1996) discussions about the organisation of knowledge gives little input as to whether the capitalisation of knowledge is complex or not.

According to Grant (1996:451), the foundations of knowledge-based view are a set of assumptions concerning the characteristics of knowledge and the circumstances of its creation and application. These include:

- Knowledge is the overwhelmingly important productive resource in terms of its contribution to value added and its strategic significance.
- Different types of knowledge vary in their transferability. The critical distinction is between ‘explicit knowledge’, which is capable of articulation (and hence transferable at low cost), and ‘tacit knowledge’, which is manifest only in its application and is not amenable to transfer.
- Individuals are the primary agents of knowledge creation and, in the case of tacit knowledge, are the principal repositories of knowledge. If individuals’ learning capacity is bounded, knowledge creation requires specialisation
- Most knowledge is subject to economies of scale and scope. This is especially the case with explicit knowledge which, once created, can be deployed in additional applications at low marginal cost.

According to the knowledge-based view of the firm, knowledge is the main resource for a firm’s competitive advantage. Knowledge is the primary driver of a firm’s value. Performance differences across firms can be attributed to the variance in the firm’s strategic knowledge base. Strategic knowledge is characterised by being valuable, unique, rare, non-imitable, non-substitutable, non-transferable, combinable and exploitable. Unlike other inert organisational resources, the application of existing knowledge has the potential to generate new knowledge (Garud and Kumaraswamy, 2005). Inherently, knowledge resides within individuals and, more specifically, in the employees who create, recognise, archive, access and apply knowledge in carrying out their tasks (Liu and Chen, 2005:643). Consequently, the movement of knowledge across individual and organisational boundaries is dependent on employees’ knowledge-sharing behaviour (Liebowitz, 2005:82). Bock *et al.* (2005) found that extensive knowledge sharing within organisations still appears to be the exception rather than the rule.

This theory emphasises the supremacy of knowledge in any organisation (Grant, 1996). Emphasis on tacit knowledge of organisations by this theory gives credence to its relevancy and applicability in the present study (see section 1.8). Research question 1 seeks to identify how tacit knowledge is generated in the five research institutes. The theory is also relevant to research question 3, which seeks to identify the KM strategies used by the research institutes to derive research and innovation. In this regard, it is natural for knowledge-based organisations to devise means and strategies for managing available knowledge emanating from daily activities for competitive advantage. The theory has been widely used in related studies such as that of Herman (2013), in a study titled 'three shapes of organisational knowledge'. The study aimed at developing a typology of knowledge that may be fruitful in facilitating research in a knowledge-based view of production. The findings showed that differences between the tacit, codified and encapsulated shapes of knowledge carry strategic implications for the firm along six important dimensions, which include locus or knowledge substrate, transferability, expression, acquisition process, source of economic value, and observability. The findings further revealed that different types of knowledge resources require different corporate strategies to maximise their value the findings, in addition, showed that law affects management and production of knowledge, thereby ultimately influencing corporate structure. Ding *et al.* (2014), in a study on knowledge-based approaches in software documentation: a systematic literature review found that: 1) there is need to use knowledge-based approaches to improve the quality attributes of software documents that receive less attention, especially credibility, conciseness and unambiguity; 2) using knowledge-based approaches with the knowledge content in software documents has received less attention in current applications of knowledge-based approaches in software documentation, to further improve the practice of software documentation activity; and 3) putting more focus on the application of software documents using the knowledge-based approaches (knowledge reuse, retrieval, reasoning and sharing) makes the most use of software documents.

2.3 Resource-based view

According to the resource-based view (RBV), firms derive competitive advantage from the possession of, or access to, unique bundles of resources and capabilities (Mahoney and Pandian, 1992; Peteraf, 1993; Teece *at al.,* 1997). In a turbulent business environment, such resource-capability bundles must entail the firm's capacity to adjust to changing environmental conditions, even as they provide continuity in daily operations. Central concepts of the resource-based view of the firm can be traced back to Penrose's (1959) theory of the growth of the firm, in which she reasons that firm growth is based on indivisibilities and inseparabilities of a firm's '… collection of productive resources, the disposal of which between different uses and over time is determined by administrative decisions' (Penrose, 1959).

Penrose (1959) defines resources as a 'bundle of potential services'. She distinguishes between physical or tangible and human resources, and underlines the significance of the tacit nature of some resources for the firm's strategic position. The resource-based view argues that firms possess resources, a sub-set of which enables them to achieve competitive advantage, and a further sub set which leads to superior long-term performance (Barney, 1991; Grant, 1991; Penrose, 1959; Wernerfelt, 1984). Empirical studies about the efficiency and firm performance using the RBV have found differences not only between firms in the same industry (Hansen and Weenerfelt, 1989: 405), but also within the narrower confines of groups within industries (Cool and Schendel, 1988). This suggests that the effects of individual, firm-specific resources on performance can be significant (Mahoney and Pandian, 1992).

Researchers and practitioners interested in the RBV have used a variety of different terms to describe a firm's resources, including competencies (Prahalad and Hamel, 1990), skills (Grant, 1991), strategic assets (Amit and Schoemaker, 1993), assets (Rossetal, 1996) and stocks (Capron and Hulland, 1999). This proliferation of definitions and classifications has been problematic for research using RBV, as it is often unclear what researchers mean by key terminology (Priem and and Butler, 2001). In analysing sources of competitive advantage, the resource-based framework makes two assumptions (Barney, 1991): (1) firms within a strategic group may be heterogeneous with respect to the strategic resources they control, and (2) resources may not be perfectly mobile and thus resource heterogeneity can be long-lasting. The resource-based model, then, evolved in the direction of recognising resource immobility or specificity (Rumelt, 1991).

The resource-based theory states that corporate reputation can be considered valuable strategic resource because it contributes to or harms a corporation's sustainable position (Keh and Xie, 2009: 378). The central tenet in resource-based theory is that unique organisational resources of both tangible and intangible nature are the real source of competitive advantage. With resource-based theory, organisations are viewed as a collection of resources that are heterogeneously distributed within and across industries. Accordingly, what makes the organisation distinctive is the unique blend of the resources it possesses that derive the competitiveness of the organisation.

Corporate reputation, for example, is an intangible resource that influences stakeholder behaviour, including employees, management, customers and investors (Friedman, 2009). The resource-based theory of the firm places specific emphasis on corporate intangibles that are difficult to imitate, such as tacit knowledge. The resource-based approach (Penrose, 1959; Wernerfelt, 1984) is attracting the attention of a growing number of researchers, precisely because the framework encourages dialogue between scholars from a variety of perspectives. In particular, three major research programmes are currently intertwined in the resource-based framework. First, the resource-based view incorporates concepts from mainstream strategy research. Distinctive competencies (Andrews, 1971; Ansoft, 1965; Selznick, 1957) of heterogeneous firms, for example, are a fundamental component of the resource-based view.

The resource-based theory is concerned with the rate, direction and performance implications of the diversification strategy, which are areas of considerable focus in the KM and strategy fields (Ramanujam and Varadarajan, 1989: 532). Second, the resource-based approach fits comfortably within the conversation of organisation economics (Barney and Ouchi, 1980). For this reason it may arguably be considered a fifth branch of the organisational economics tree of knowledge, along with the positive agency theory (Eisenhardt, 1989), property rights (Alchian, 1984; Coese, 1960) and transaction cost economics (Nelson and Winter, 1982). Conner (1991) persuasively reasons that the resource-based approach reflects a strong industrial organisation approach and is, at the same time, unique for competitiveness.

In recent years, the resource-based view of competitive advantage (Barney, 1986; 1991; Wernerfelt, 1984) has generated insightful debates and informed research aimed at obtaining a better understanding of why some firms outperform others. This view of strategy (hereafter RBV) emerged in the early 80s as a response to the environmental determinism of the industrial organisation-based perspective on business policy and strategic management, as developed by Porter (1985). The industrial organisation perspective essentially reduced the managerial imperatives to the analysis of a given industry's structure and the selection of a predetermined set of strategic postures (Bain, 1968; Mason, 1957). In response, the RBV emerged in consonance with the development of the strategic choice perspective (Child, 1972) that rejected the constricted views of industrial organisation economics and sought to ascribe greater importance to the roles of managerial judgment and organisational idiosyncrasies in influencing firm behaviour and outcomes. In a nutshell, the RBV's core thesis is that firms which possess valuable, rare, imperfectly imitable and non-substitutable resources enjoy sustained competitive advantage over their rivals (Barney, 1986; 1991). In its initial conceptions, the term 'resources' was used to cast a wide net over several elements, ranging from managers and employees, patents, brands, information and financial capital. In further theoretical developments, the RBV has been expanded by viewing managers as boundedly rational, who must make resource choices with imperfect information (Amit and Schoemaker, 1993). The introduction of bounded rationality links the RBV with the evolutionary theories of the firm that view the development of resources as intrinsically embedded in a firm's history and culture.

These views shift the focus of the RBV from resources, *per se*, to the notion of organisational capabilities and routines inherently grounded in organisational knowledge (Nelson and Winter, 1982). These insights, taken together, have resulted in the development of theoretical streams, such as the dynamic capabilities perspective and the knowledge-based view of strategy (KBV). These perspectives focus specifically on organisational competencies, capabilities and knowledge that are essentially intangible (Grant, 1996; Prahalad and Hamel, 1990; Teece, Pisano and Shuen, 1997). The resource-based theory contributes to our understanding of how resources are applied and combined, what makes competitive advantage sustainable and the origins of heterogeneity. In chronological order, notable contributions to the resource-based framework include Teece (1980); Lippman and Rumelt (1982); Rumelt (1984); Wernerfelt (1984); Barney (1986; 1991); Dierickx and Cool (1989); Reed and DeFillippi (1990); Castanias and Helfat (1991); Conner (1991); Grant (1991); Mahoney and Pandian (1992); Amit and Schoemaker (1993); Peteraf (1993); Black and Boal (1994); Chi (1994); and Miller and Shamsie (1996). While each study offers a distinct contribution and approach, there is also considerable overlap of ideas.

The down side of the resource-based theory is the focusing explicitly on organisation-specific resources and knowledge as the ultimate resource for organisational success, thereby ignoring the contribution of resources beyond organisation and other knowledge management infrastructure such as technology, culture, databases/repositories as an indispensable part and resources for competitiveness.

This theory believed that the success and attainment of competitive advantage by organisations is determined by possession of, or access to, bundles of resources such as the tangible (e.g. human resource/manpower, facilities) and intangible (e.g. skills, expertise). In this regard, the theory is relevant in addressing variables in research question 1 (tacit knowledge) and research question 6 (human resource/manpower) of the present study. Resource-based theory has been used in related studies by Rajiv (2006) in a PhD study at the University of Pennsylvania, entitled ‘From common to uncommon knowledge: an investigation into socio-cognitive foundations of inter-firms heterogeneity in the use of knowledge as a resource’. The findings revealed that executive knowledge schemes significantly influenced the amount and nature of scanning behavior that a focal executive engages in. Also, it shows that the nature of knowledgeable practice mediates the relationship between a firm’s human, social and technological capital (i.e. its tangible knowledge assets) and its innovation capacity. Joseph and Rajendran (1992), in a study, ‘Resource-based view within the conversation of strategic management’ demonstrated that resource-based theory incorporates traditional strategy insights concerning a firm’s distinctive competencies and heterogeneous capabilities and also provides value-added theoretical propositions that are testable within the diversification strategy literature.

2.4 Competence-based view

A competence-based perspective focuses on those competencies of employees that are relevant for successful behavior. Advantages of a competence-based approach are that competencies are assumed to be recognisable, assessible and relevant for practice (Hayton and Kelly, 2006). In contrast to stable personality traits, competencies can be developed; and they relate to organisational effectiveness (Hamel and Prahalad, 1994; Spencer and Spencer, 1993). The competitive advantage of organisations, in the long run, is to derive from the ability to build and leverage competencies at lower cost and more speedily than competitors (Prahalad and Hamel, 1990). Further, their view stresses the dynamic nature of competencies, suggesting that competencies should be nurtured, protected, sustained and developed. The competence-based view is primarily represented by authologies such as Sanchez *et al.* (1996), Heine and Sanchez (1997) and Sanchez (2001b). The perspective rests solidly on resource-based thinking. In this regard, firms utilise competence in order to reach set goals and targets, regardless of whether or not it is reduced costs or competitive advantage. But the core of the competence-based perspective lies in its approach to the nature of knowledge and of its discussion of learning processes (Sanchez, 2001b). For instance, the difference between data, information, knowledge and interpretive frameworks is highlighted, as is the difference between learning and sense making. The relations between assets, resources, skills, competences, capabilities and competencies are elaborated upon (Sanchez, 2001b). A key feature is the transformation of knowledge into competence, which is made through learning cycles, encompassing individual, group and organisational learning (Sanchez, 2001b).

In this perspective, however, the management of the transformation of knowledge to set goals is not well and clearly articulated and covered. The competence-based approach to strategy also focuses on the 'internal factors', such as organisational culture, staff strength and operational efficiency, in explaining firms' performance differentials. The term 'distinctive competence', which is the main thrust of this theory, was first introduced by Selznick (1957). It refers to those things that an organisation does especially well in comparison to its competitors. The intellectual roots of the competence-based theory can be found in the works of Snow and Hrebiniak (1980), Nelson and Winter (1982), Hitt and Ireland (1985) and Prahalad and Hamel (1990). Wernerfelt (1995), one of the founders of the resource based theory, credits Prahalad and Hamel's (1990) work as 'single-handedly responsible for diffusion of the resource-based view into practice'. Works that have stimulated the advancement of the competence-based theory can be found in the conceptual and empirical articles of Lado *et al.* (1992), Leonard-Barton (1992), Day (1994), Henderson and Cockburn (1994), Aaker (1995), Teece, Pisano and Shuen (1997), Sanchez *et al.* (1996), Sanchez and Heene (1996; 1997), Li and Calantone (1998) and Eisenhardt and Martin (2000) representing both management and marketing domains of an organisation.

According to Kandemir and Hult (2005), the resource-based theory and the competence-based approach are complementary. While for the resource-based theory a firm is a portfolio of resources (e.g. physical, human and organisational) (Barney, 1991), for the competence-based approach a firm is both a collection of products and a collection of competences (Prahalad and Hamel, 1990). The competence-based approach appears to be a more actionable version of the resource-based theory, with more emphasis on the sources of competitive advantage within the firm. Firms utilise competence in order to reach set goals, regardless of whether or not it is reduced costs or competitive advantage. A key feature is the transformation of knowledge into competence, which is made through diffusion, learning cycles, encompassing individual, group and organisational learning (Sanchez, 2001a). However, the management of the transformation of knowledge into set goals is not well covered by the theory.

The theory perceived organisations as a collection of products and competencies, the utilisation of which culminates in the attainment of set goals. In this regard, competence-based theory is action-oriented through galvanisation and optimum use of staff potentialities to achieve the organisational objectives. It supports the notion of 'use what you have to get what you want' in business practices. Even though the theory was emphatic on attaining competitive advantage by organisations; it is limited in describing the practical ways for achieving such through knowledge conversion, which is one of the focuses of this study. These limitations have made the theory not wholly applicable for this study, but some of its constructs such as organisational skills, human capital application, internal factors, and distinctive competence can be used to address research questions 1, What type of knowledge is generated by the Nigerian agricultural research institutes? and research question 6, What factors influence knowledge management adoption in the research institutes? (see section 1.8). The theory has been successfully applied in related studies on KM within the disciplines of economics, business management and marketing. For instance, Kandemir (2005) in a PhD study at the Michigan State University, entitled 'A study of market knowledge competence as a source of SBU performance' found that that retailer/distributor equity increases market knowledge competencies; however, no association was found between supplier equity and market knowledge competence. Market orientation culture was found to contribute to the level of market knowledge competence. On the other hand, market knowledge competence enhances customer performance, increases the speed of marketing strategy formulation and implementation and improves marketing learning performance.

2.5 Capability Perspective Theory

The Capability Perspective Theory 'emphasises the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organisational skills, resources, and functional competencies to match the requirements of a changing environment' (Teece *et al.,* 1997). Because the capabilities approach focuses on processes, a business can still specialise in one or a few specific processes that they do best, but these processes should be overarching, so that they can impact all business assets. The capabilities approach is a holistic approach, not only because it allows overarching competencies to be developed, but also because it focuses on both the internal and external environments. This approach allows businesses to become superior at one capability, which will enable them to utilise all external and internal assets in the most competitive manner.

Capabilities are complex bundles of skills and knowledge embedded in organisational processes (Helfat and Peteraf, 2003). They are critical sources of sustainable competitive advantage used by firms to leverage their assets and achieve superior performance. Distinctive capabilities enable firms to meet customer needs more effectively and cost efficiently. Capabilities serve as the 'glue' that binds different resources together and allows them to be deployed to maximum advantage (Day, 1994). The predominant view in past research work is that capabilities are positively associated with performance (Day, 1994). Nevertheless, several studies report that capabilities can turn into core rigidities and might even have a negative influence on some aspects of firm performance (e.g. Atuahene-Gima, 2005; Haas and Hansen, 2007; Leonard-Barton, 1992). Therefore empirical generalisations through a meta-analysis would help in assessing the overall impact of firm capabilities on performance and highlight study characteristics that may cause variation in the capability-performance relationship.

Operations capability describes the skills and knowledge that allow a firm to be efficient. Treacy and Wiersema (1993) explain that superior customer value can be delivered through operational excellence, customer intimacy and product leadership. These strategies are evidently related to operations capability, marketing capability and R&D capability in organisations such as agricultural research institutes, for effective service delivery. The resource-based view of the firm reasons that resources, and the capabilities that enable the deployment of these resources, are the fundamental reasons why some firms perform better than others (Teece *et al.,* 1997). Capabilities reside in organisational processes and routines that are difficult to replicate, enabling firms to enjoy sustainable advantage over their rivals. Capabilities have been demarcated into those that belong in different functional areas such as R&D, products development and marketing in the case of research institutes. Marketing capability, therefore, is the organisational competence that supports market sensing and customer linking (Day, 1994).

Marketing capability spans those processes established within organisations to sense customer needs through effective information acquisition, management and use, to decipher the trajectory of customer needs and preferences. In addition, marketing capability involves the processes that allow a firm to build sustainable relationships with customers through stronger customer interaction with a firm or its brands (Day, 1994). R&D capability refers to the processes that enable a firm to invent new technology, as well as convert existing technology, to develop new products and services. Therefore R&D capability will depend on the processes that help a firm develop new technical knowledge, place it in the context of existing technical knowledge and use this knowledge to design superior products and services. This is more relevant to the focus of the present study, where researchers in the agricultural research institutes use capabilities to innovate and create new products and leverage them for customers and societal good, in general.

Capabilities, as noted previously, are deeply rooted processes that are often not explicitly visible. The measurement of capabilities has frequently been based on secondary proxy measures that are considered their valid outward manifestations. For instance, marketing capability has been assessed using measures such as market research and advertising expenditures (e.g. Dutta *et al.,* 1999). Furthermore, the measurement of R&D capability has been approached in a manner similar to that used in capturing marketing capability. The most frequently used measure of R&D capability has been some operationalisation of R&D expenditure, which is often standardised relative to industry expenditures and expressed as R&D intensity (e.g. Kotabe *et al.,* 2002; Dutta *et al.,* 1999). Other measures focus on R&D productivity, e.g. patent output or new product output (e.g. Penner-Hahn and Shaver, 2005).

In general, capabilities are developed by organisations through path-dependent evolutionary processes (Helfat and Peteraf, 2003) and cannot be easily acquired, transferred, or mimicked (Teece *et al.,* 1997). Capabilities are embedded in the routines through which managers acquire, integrate and deploy resources to generate firm value (Day, 1994; Grant, 1996; Eisenhardt and Martin, 2000). Capabilities are thus quite resistant to competitive attempts to imitate them

(Dierickx and Cool, 1989). Danneels (2002) proposes that existing capabilities may serve as leverage points for the development of new ones that help a firm sustain its performance. Overall, capabilities are critical determinants of a firm's competitive advantage and, hence, its performance (Day, 1994).

According to Teece *et al.* (1997), perhaps the most fundamental contribution of the resource-based view of the firm came when authors began shifting from the analyses of tangible assets to the analysis of intangible assets. Some of these intangible assets that have been examined in the literature are organisational culture, human know-how (knowledge resources) and other information and relational resources (Hunt and Morgan, 1999). According to Teece *et al.* (1997), the contribution of the intangible assets allows for an examination of the acquisition, learning and accumulation of these assets to create capabilities. These individual processes, from which a firm can acquire, learn about and accumulate resources, allow a firm to have a well-focused vision. They can still focus on a few specific things (to prevent over-diversification), which in the capabilities approach would be processes instead of resources, but they can use these processes in the development and deployment of many, diverse resources. Instead of focusing on one specific asset or resource, a firm can focus on a specific capability. The processes, which are necessary to allow for this transformation, became the cornerstone of the capabilities approach.

Teece *et al.* (1997), along with Eisenhardt and Martin (2000), claim that capabilities make up the abilities to create and utilise resources to improve performance. Like many of the other perspectives mentioned, the capability perspective suggests that knowledge is important and that it can contribute to improved performance. However, despite identifying the link between capabilities and performance, it is not very clear on how this link is managed and whether or not there is automatic casualty between capabilities and performance. This theory identified competencies as dynamic capabilities in an approach to stress exploitation of existing internal and external firm-specific competencies, to address changing environments. The theory also emphasised the exploitation of the firm-specific existing knowledge in the creation of new knowledge to enhance productivity and development, which is the main concern of this study. According to the theory, knowledge capabilities include expertise, knowledge documents, lessons learned, policy and procedures, and data.

Though the theory is tacitly knowledge-based, some of its attributes are explicit knowledge-oriented, such as knowledge documents, policy and procedures. Hence the effective application of the theory to research question 1 of the present study, What type of knowledge is generated by the Nigerian agricultural research institutes?. In a similar vein, the theory can be used to address research question 3, What knowledge management strategies are used by the research institutes to drive research and innovation? (see section 1.8), since the use of organisational capabilities could direct and galvanise the management of knowledge and other resources of an organisation for improved performance and competitive advantage. Similar studies have used the theory. Alexander (2007), in a PhD study at the University of South Carolina, examined the relationship between marketing capability and firm performance, using the dynamic capabilities perspective (Teece *et al.,* 1997). Their study demonstrated that marketing capability has a stronger effect on performance than operational capability. It demonstrated that customer relationship management capability has a negative effect on firm cost efficiency and a positive effect on firm profitability. Overall, the study by Alexander (2007) provides new insights into the role of marketing capabilities on firm performance. Foley (2005), in a PhD study at the University of Mississippi, entitled 'The conceptualization and integration of marketing and learning capabilities: implication for organizational performance' found that market information processing and learning capabilities have significant, positive effect on dynamic marketing capabilities, which, in turn, have a positive effect on creativity, which then has positive effects on customer satisfaction, market effectiveness and financial performance.

2.6 Knowledge Category Model

The Knowledge Category Model supports the Nonaka and Takeuchi (1995) theory, by regarding organisational knowledge as either codified or uncodified and as diffused or undiffused. The term codified means that knowledge can be captured and transmitted (for example, proprietary knowledge), while uncodified refers to knowledge that cannot readily be transmitted (for example, experience). The term 'diffused' denotes knowledge that can be easily shared and 'undiffused' refers to knowledge that is difficult to share. Boisot (1987) uses a different knowledge category model. If knowledge is both codified and undiffused, then the knowledge is regarded as proprietary knowledge (Boisot, 1987). Knowledge is prepared for transmission in this case, but it is only limited to a selectively small population on the 'need to know' basis, such as share price issue.

	Undiffused	Diffused
Codified	Propriety Knowledge	Public Knowledge
Uncodified	Personal Knowledge	Common Sense

Figure 2.1 Boisot's (1987) Knowledge Categorization (adapted from Boisot 1987)

As can be seen in Figure 2.1, personal knowledge, indicated on the left, bottom quadrant, covers knowledge that is uncodified and undiffused, such as perceptions and insights. The top right quadrant refers to public knowledge, which covers both codified and diffused knowledge in journals and books (Boisot, 1987, cited in Steyn, 2003).

According to McAdam and McCreedy (1999), there is some correspondence between Nonaka's model and that of Boisot. This is because Nonaka's categorisation of explicit and tacit knowledge partially parallels Boisot's codified and uncodified knowledge. The Boisot model suffers some limitations, in that codified and uncodified are but two discrete categories of knowledge. Also, the idea of diffused knowledge (less defined ontological axis than Nonaka's model) is rather general and it is not clear if it includes incorporating knowledge within the organisation, as well as spreading it. In summary, the Knowledge Category Model of knowledge management involves knowledge transforming processes of socialisation.

The attributes of the knowledge category model, such as codified knowledge (diffused) and uncodified knowledge (undiffused), are directly related to research question 1 of this study, What type of knowledge is generated by the Nigerian agricultural research institutes? (see section 1.8). This question seeks to identify the type of knowledge generated in the Nigerian agricultural research institutes. This classification has been covered by the principal theory of this study (see section 2.8). The Knowledge Category Model corroborated the theory of Nonaka and Takeuchi, which described knowledge as either tacit or explicit. In the context of the present study, the Knowledge Category Model is helpful and consistent with the understanding of the type of knowledge generated by the Nigerian agricultural research institutes in the course of their research and development (R&D) activities. In this regard, generation of tacit knowledge is largely through interaction between and among the researchers who share experience on the lesson learned, policies and procedures, specifications and strategies, while generation of explicit knowledge is through documentation of research results, research reports, procedures and processes and new products developed such as seeds and seedlings, farm implements, pesticides, etc.

The Knowledge Category Model has been used in several related studies in the area of knowledge management within the disciplines of business, management and economics. For example, Steyn (2003), in a study 'Creating knowledge through management education: a case study of human resource management', found the intervention used in the learning material extended each learner's repertoire of knowledge and skills; helped learners to achieve their own goals and develop the organisation for which they worked. Lwoga (2010), in a study of 'Knowledge management approaches in managing agricultural indigenous and exogenous knowledge in Tanzania' demonstrated that Western-based KM models should be applied cautiously in the developing world context.

2.7 Cognitive-Framework Model

This theory is tacitly knowledge-based, as it emphasises cognitive functions such as memory, comprehension and organisational learning. It acknowledges the role of knowledge in performing cognitive tasks such as problem-solving in organisations. According to Ginsberg (1994), socio-cognitive capabilities represent a scarce resource that cannot be easily imitated. Possession of these scarce socio-cognitive capabilities is valuable because it allows members of the firm, and in particular senior managers, to make better quality decisions about the deployment of extant resources. Cognitive capacity is defined as the capacity to '. . . register, store, use and make sense of data' (Gronhaug, 1992: 62). It is possible to identify a number of propositions in the theoretical literature concerning the effects of cognitive capacity on performance. Prahalad and Bettis (1986) have reasoned that the size of a diversified firm is limited by the ability of the top management team to manage strategic variety, where strategic variety refers to '. . . the differences in strategic characteristics of the businesses in the portfolio of the firm' (Prahalad and Bettis, 1986:489).

According to this view, the complexity of the top management process is a function of strategic variety. Increasing strategic variety requires the addition of new dominant logics or ways of managing, especially among the top management team, who are usually responsible for the allocation of resources among business units. Prahalad and Bettis (1986) view the inability of the top management team to assimilate new dominant logics as a major limiting factor in diversification. As a corollary, a top management team that attempts to stretch a single dominant logic over a range of unrelated businesses will perform poorly relative to a more tightly focused team.

A relationship therefore exists between cognitive capacity and the number of dominant logics possessed by the firm. An increase in strategic variety requires an increase in cognitive capacity and an increase in the number of dominant logics. However, whereas cognitive capacity implies some quantitative measure of the sense making ability of a firm, the dominant logic viewpoint reminds us that qualitative change in management outlook most likely also occur in order to respond appropriately to complexity (Phelan, 2002).

Since the theory focuses on cognitive functions such as skills, experience, memory, comprehension and organizational learning, it can be appropriately used to address research question 1, What type of knowledge is generated by the Nigerian agricultural research institutes? And research question 4, How is the knowledge generated disseminated? (see section 1.8). The theory is a tacit knowledge-dominant, hence its appropriateness to address research question 1, to unfold how researchers in the five research institutes share expertise, research skills and experiences through formal and informal fora. For the research question 4, the theory addresses means and methods of knowledge dissemination and knowledge spiral (from individuals, groups and organisational and inter-organisational levels). In this context, agricultural research institutes' primary responsibility is to produce and disseminate knowledge through varied means such workshops, seminars, conferences, extension services and pamphlets. The Cognitive-Framework Model has been used in a related study by Steven (2002), titled 'Cognitive capacity as competitive advantage: a simulation test'. The study demonstrated that firms with a higher cognitive capacity are capable of outperforming firms with a lower cognitive capacity.

2.8 Knowledge-Creating Theory

This study is underpinned by the Knowledge-Creation theory of Nonaka and Takeuchi (1995), complemented by the other knowledge management theories/models that have been described above. The reasons for adopting the theory of Nonaka and Takeuchi (1995) are twofold; first, the theory is widely used in various research works similar to the present one. For instance Chun-Ming *et al.* (2012) in a study of factors affecting KM success: the fit perspectives based on an aerospace manufacturing company in Taiwan, the study of Gregorio *et al.* (2008) on processes of knowledge creation in knowledge-intensive firms: empirical evidence from Boston's route 128 and Spain, the study of Choi and Lee (2002) on KM strategy and its link to the knowledge creation process, the study of Aybuke *et al.* (2008) that investigated KM practices in software development organisations: an Australian experience, the study of Mellor (2011) on knowledge management and information systems: strategies for growing organisations, the study of Boisot (1998) on knowledge assets: securing competitive advantage in the information economy, the study of Gourlay (2006) of the SECI model of knowledge creation: some empirical shortcomings, the study of Lwoga (2011) on knowledge management approaches in managing agricultural indigenous and exogenous knowledge in Tanzania, and the study of Lwoga *et al.*

(2010) on managing indigenous knowledge for sustainable agricultural development in developing countries: a case study of Tanzania.

Secondly, the theory, as much as possible, covers all the variables of the present study and provides a broad explanation and a robust theoretical perspective. The theory, in particular, emphasises knowledge identification, acquisition, development, sharing, preservation and application of knowledge. The theory describes the existence of two types of knowledge, tacit (based on intuition, experience, skills, belief, mental model) and explicit (codified knowledge found in documents, databases/repositories). Nonaka and Takeuchi (1995)'s Knowledge-Creation Theory espouses two dimensions of knowledge creation - the Epistemological Dimension and the Ontological Dimension (Nonaka and Takeuchi, 1995). The Epistemological dimension deals with the four modes of knowledge conversion, namely socialisation (tacit to tacit) that creates synthesized knowledge; externalisation (tacit to explicit) that creates conceptual knowledge; combination (explicit to explicit) that creates systematic knowledge; and internalization (explicit to tacit) that creates operational knowledge. All these modes of knowledge creation are not independent, but interact to create a knowledge spiral, which produces new products and innovations. The Ontological Dimension deals with the level at which these KM processes of knowledge identification, acquisition, development, sharing, preservation and application of knowledge take place. The model describes the KM strategies as starting from sharing tacit knowledge as the basic, creating concept, such as metaphor and analogy, justifying the concept, then building and archetype in form of prototype and, lastly, cross levelling knowledge by way of subjecting it to various sections/departments for evaluation, scrutiny and further screening.

The variables of the Knowledge Creating Theory mapped with the study objectives and research questions, are presented in Table 2.1.

Table 2.1 Research questions/research objectives mapped onto Nonaka and Takeuchi knowledge creation theory variables

S/N	Research Objectives	Research Questions	Key Variables of the Theory
1.	Identify the type of knowledge generated by the Nigerian agricultural research institutes	What type of knowledge is generated by the Nigerian agricultural research institutes?	Tacit, explicit knowledge
2.	Establish the extent of knowledge production by the research institute	What is the extent of knowledge production in the research institutes?	Epistemological dimension/ knowledge conversion
3.	Identify KM strategies used by the research institutes to derive research and innovation	What knowledge management strategies are available in the research institutes to derive research and innovation?	Sharing tacit knowledge, creating concepts, justifying concepts, building archetype and cross levelling knowledge
4.	Determine how knowledge generated disseminated	How is the knowledge generated disseminated?	Knowledge spiral
5.	Identify KM infrastructure available in the research institutes	What knowledge management infrastructure is available in the research institutes?	People, technology, leadership, culture, systems, networks, databases/repositories
6.	Investigate factors influencing KM adoption in the research institutes	What factors influence KM adoption in the research institutes?	Knowledge creating crew (knowledge officers, knowledge engineers, and knowledge practitioners)

2.9 Summaries of the theories

Having reviewed the principal and complementary theories underpinning this study, the researcher in Table 2.2 assessed and summarised the theories on the basis of aspect covered, strength and weaknesses, in the context of the present study (Literature Review, 2014).

Table 2.2. Summaries of the theories

Name of Theory	**Aspects Covered**	**Strength of the Theory**	**Weaknesses of the Theory**
Knowledge-Based View	Tacit knowledge, i.e. knowledge of the mind	The theory represents a confluence of a number of streams of research such as resource-based theory and epistemology	Emphasis on tacit knowledge as the ultimate source of competitive advantage thereby relegating the role of explicit knowledge as an important source of knowledge for firm performance. This partially approaches the management of knowledge conversion and with levity
Resource-Based Theory	Resources; capabilities; competencies; skills; assets	Acknowledges the unique organisational resources of both tangible and intangible nature as the real source of competitive advantage. As KM theory, RBV stimulates conversion within organisations and enhances strategic management of the	Focusing on organisation-specific resources/knowledge as the ultimate resource, thereby ignoring the contribution of resources beyond organisations and other KM infrastructure such as technology, culture, databases/repositories.

		available resources.	
Competence-Based View	Tacit knowledge; capabilities, competencies, skills	Built on intellectual basis of resource-based theory. Perceived organisational/firm as a collection of products and competencies that could drive competitive advantage	Non-specificity about the management and transformation of knowledge into set goals.
Capability Perspective Theory	Expertise, knowledge documents, lesson learnt, policy and procedures, data	Recognizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organisational skills, resources and functional competencies to match the requirement of a changing environment.	Lack of clarity on the link between capabilities and performance. Emphasis on the exploitation of the firm-specific existing knowledge, as against the creation of new knowledge through external sources to enhance productivity and development.
Knowledge Category Model	Codified knowledge, uncodified knowledge	Supports Nonaka and Takeuchi (1995)'s knowledge-creation theory by classifying knowledge into codified (explicit) and uncodified (tacit)	Some of the categorisation of knowledge is mechanistic, in that the idea of diffused knowledge is rather general and is not sure if it includes incorporating knowledge within the organisation, as well as spreading it.
Cognitive-framework	Tacit knowledge; memory,	Acknowledged the role of tacit knowledge in	Non-recognition of explicit knowledge as a source of

Model	comprehension and organisational learning	performing cognitive tasks such as problem-solving in organisations. Cognitive capabilities represent a scarce resource of an organisation that cannot be easily imitated and possession of which could enhance quality decisions.	firm performance and emphasis on top management cognitive capabilities alone
Knowledge-Creation Theory	Tacit knowledge, explicit knowledge, knowledge spiral, knowledge conversion, KM strategies, KM infrastructure, knowledge adoption	All-encompassing and wide-applicability. Provides a broad explanation and theoretical perspective.	Too much recognition and emphasis on knowledge creation and little on other KM processes such as knowledge processing, knowledge preservation, knowledge re-use. Over-emphasis on private and business practices and less on government-sponsored organisations

CHAPTER THREE

REVIEW OF RELATED LITERATURE

3.1 Introduction

The focus of the Chapter Three is the review of available literature related to this study. A review of the literature involves the finding, reading and evaluating of outputs of previous studies, observations and opinions pertaining to the area of investigation (Mugenda and Mugenda, 2003). It surveys scholarly texts and empirical studies on previous research and expands the foundation for further research, thus determining the importance of the research area (Kothari, 2004; Sheppard, 2004; Gravetter and Forzano, 2009). It captures published and unpublished work from secondary sources and draws attention to important variables, as determined in previous studies that are related to the research problem being investigated and significant findings in the area of investigation (Hart, 1998; Sekaran, 2003). The present study sought to address the following research questions: 1) What type of knowledge is generated by the Nigerian agricultural research institutes? 2) What is the extent of knowledge production by the research institutes? 3) What knowledge management strategies are used by the research institutes to drive research and innovation? 4) How is the knowledge generated disseminated? 5) What knowledge management infrastructure is available to the research institutes? 6) What factors influence knowledge management adoption in the research institutes?

Literature covered in the chapter focuses on paradigms and methodology (Creswell, 1994; Greene, Caracelli and Graham, 1989; Salomon, 1991). The scope of the literature surveyed covers both empirical and conceptual literature from scholarly journals, theses, websites, monographs, textbooks, conference proceedings, peer-reviewed books of abstracts, essays, non-empirical works, research syntheses and major specialised and general databases such as AGRICOLA, ScienceDirect, AGRIS, Agricultural Journals via ProQuest and Google Scholar.

The geographic coverage of the literature reviewed includes the world view, the African view and then Nigeria view. The lens used to review the literature was the research questions of the study and the major variables of Nonaka and Takeuchi (1995)'s Knowledge-Creation Theory, which underpinned this study. Thematic areas from the research questions include: knowledge production and generation in the agricultural sector; knowledge management strategies and agricultural research; knowledge dissemination in agricultural research; and factors influencing knowledge management adoption in agricultural research institutes. Key variables from the underlying theory are: explicit knowledge versus tacit knowledge; knowledge management infrastructure; and knowledge spiral. The broader issues around the research problem in this study include: knowledge management; the agricultural sector; agricultural research; and knowledge workers within each theme. The international context is reviewed, followed by the regional and local contexts.

3.2 Knowledge production and generation in agricultural sector

Knowledge is known to exist in various forms, though two of these forms have emerged in the literature as the most common. These two forms have been generally accepted and are explained in depth in literature. The most common forms of knowledge are classified either as tacit knowledge or as explicit knowledge (Nonaka, 1994; Nonaka and Takeuchi, 1995; Tuomi, 1999; Lim and Klobas, 2000; Boisot, 1987). In one of his last publications, 'The many shapes of knowledge', Simon (1999) suggested that we are becoming increasingly aware that knowledge plays a central role in economic processes. This realisation has called attention to the difficult problem of gauging the cost and value of knowledge as a factor of production. Our inability to measure accurately the cost and value of knowledge presents a grave impediment to the efficient and profitable conduct of business (Simon, 1999). Choo, drawing on Polanyi (1966) and Nonaka and Takeuchi (1995), distinguishes between tacit knowledge, as ‘‘knowledge that is uncodified’’ (Choo, 1998), and explicit knowledge, as ‘‘knowledge that can be expressed formally using a system of symbols’’ (Choo, 1998). Choo also includes object-based knowledge, ‘‘found in artefacts such as products’’, under the heading of explicit knowledge (Choo, 2006).

The term 'explicit', however, implies observability and not all non-tacit knowledge is observable. Observability has important implications for transferability, replication and appropriation of value. Choo (2006), for example, recognises that object-based explicit knowledge may remain unobservable unless it is unpacked through reverse engineering, inspection or compositional analysis. Tacit knowledge has intrigued researchers for many years and has been described in a multitude of ways: practical know-how (Koskinen, 2003), difficult to articulate (Teece, 1998b), transferred only via observation and practice (Harigopal and Satyadas, 2001), subconsciously understood and applied (Zack, 1999b) and rooted in action, experience and involvement in a specific context (Nonaka, 1994). Similarly, explicit knowledge has a wealth of research to depict the essence of this knowledge type as being: embodied in a code or language (Koskinen, 2003), knowledge already documented (Harigopal and Satyadas, 2001), precisely or formally articulated (Zack, 1999) and articulated, codified and communicated in symbolic form and/or natural language (Alavi and Leidner, 2001). A holistic view of organisational knowledge assets must encompass a view of both the tacit and explicit nature of knowledge. The connection between tacit and explicit knowledge has been recognized, in which 'tacit knowledge is the means by which explicit knowledge is captured, assimilated, created and disseminated' (Fahey and Prusak, 1998) and where tacit knowledge forms the background necessary for assigning the structure to develop and interpret explicit knowledge (Alavi and Leidner, 2001; Polanyi, 1975). These connections imply a continuum that Koskinen (2003) provided as a scale of media richness externalisation that runs in order from: face-to-face (tacit knowledge), telephone, written personal, written formal, numeric formal (explicit knowledge).

Agricultural researchers (research institutes, universities, NGOs, private companies and farmers) are engaged in developing technologies, finding new ways of improving agricultural production and the value of agricultural products. Research helps to solve specific scientific problems and provides policy-makers with methods and tools that help to formulate policies. Research provides assessments of farming practices and policies and points out necessary reforms. Making their contribution, Roling and Wagemakers (1998) indicated that farmers were expected to become experts in external wisdom and technologies and were not just adopters of technology. They made the point that farmers needed to adapt the new practices to suit their local situation. This implies that farmers, too, need to experiment and be part of the process to enhance their farming systems. This point was supported by literature reviews, which pointed out that farmers have been experimenting and innovating on their farms for many years (Alders *et al.,* 1993; Shrestha, 1996). Knowledge is not static and changes continuously (Katz 1998; Riley 1998). The old knowledge equation was: 'knowledge is power, so collect it'. This has been replaced by: 'knowledge is power, so share it in order for it to multiply' (Allee, 1997). This means that people and organisations should continuously renew and create more knowledge (Allee, 1997).

Knowledge creation was defined by Argote *et al.* (2003) as new knowledge that is generated within an organisation. He stressed that knowledge could be generated at each level of analysis:

- job/individual;
- team;
- organisation; and
- industry.

Knowledge creation could be stimulated, partially, by a lack of congruence or a lack of fit between knowledge structures (Argote *et al.,* 2003). Nonaka *et al.* (2006) expanded the definition of knowledge creation to reflect an organisational level of analysis. They defined organisational knowledge creation as a process, where knowledge created by individuals is made available, then crystallised, into an organisation's knowledge system.

Within this knowledge creation process, knowledge created by an individual is shared by team members, which is then transferred to the team and codified into written or digital format, and finally becomes part of the organisation's knowledge system, supporting the knowledge management process. The competitive advantage lies in people's skills and knowledge and the organisation's ability to nurture the concept of lifelong learning (Bassi, 1997; Robinson and Ellis, 1999; Martensson, 2000; Hicks, 2000; Cascio, 2001). Knowledge results when people transform information into their personal knowledge store and create new knowledge (Todd, 1999; Shariq, 1998; O'Connell, 1999; Martensson, 2000). Knowledge workers carry knowledge as a powerful resource which they, rather than the organisation, own (Kinnear and Sutherland, 2000). Knowledge workers are valuable in the organisation because they look for innovation which increases choices and thereby increases the organisation's knowledge assets (Bagshaw, 2000).

Knowledge creation in organisations such as agricultural research institutes starts with people sharing their internal tacit knowledge by socialising with people or by obtaining it in digital or analogue form (Riley, 1998; Bassi, 1997). The shared knowledge is then internalised by other people who generate new knowledge. This newly created knowledge is again shared with other people and the process repeats itself. It has no use if organizations have people with intellectual capital who do not share it (Katz, 1998; Riley, 1998). The creation of knowledge through self-reflection and interaction with other people is essentially a human process (Shariq, 1998; Bassi, 1997). Contexts are developed and interpreted during extensive interaction with situations and experiences in practice (Shariq, 1998). Since knowledge workers such as researchers are critical in creating, sharing and diffusing knowledge in organisations, they are simultaneously involved in the process of changing contexts, their own and that of others in the organisation (O'Connell, 1999; Bassi, 1997; Riley, 1998; Kinnear and Sutherland, 2000).

Nicke and Ayola (2004), cited in Uganneya *et al.* (2013) reported that 81 government and higher education agencies engaged in agricultural research in Nigeria in 2000. Together they employed over 1 352 full-time equivalent researchers and spent 3.6 billion naira in 1999 on agricultural research and development equivalent to US$106 million in 1993 (international price) yet the rate of growth and development of agricultural innovation has in the recent past not been encouraging. A more important factor responsible for low agricultural production is related to the fact that researchers/lecturers, students, extension workers and other stakeholders are not adequately provided with information services and resources that would improve agricultural production through innovation development and management. Other studies have revealed different scenarios in the system, for example since the discovery of Nigerian oil in the 1970s, agriculture's significance has declined, and oil now totals 95% of exports and 40% of government revenue (EIA, 2012).

Agriculture accounts only for 0.2% of exports (Daramola *et al.,* 2008). Declining agricultural production arising from total dependence on crude oil export as a means of growing the economy may suggest that the role played by the agricultural research institutes in innovation, research and development (R&D) and knowledge discovery has diminished. This is evident from the nation's agricultural sector contribution to the GDP, which dropped to 30.9% in the year 2013. In contrast, the industrial sector contributed 43% to the GDP (CIA World FactBook, 2014). Nigeria is therefore increasingly becoming dependent on food imports to feed its rapidly growing population of 174 507 537 people (CIA World FactBook, 2014). The published literature on agriculture and allied sciences is scattered over a variety of documents such as books, journals, newsletters, the internet and conference papers; reviewing and using this widely dispersed agricultural information is thus a challenge to researchers and other stakeholders in agricultural development. The necessity to sustain agricultural production rests squarely on the quality and effective information and KM activities in the country.

Knowledge is a vital resource that can be managed for the improvement of agriculture (Engel, 1997; Salomon and Engel, 1997). Knowledge and skills are essential resources for farming. Studies concerning ways in which farmers obtain and share knowledge are invaluable to farming systems research and extension, and in informing policy (ETC East Africa, 2000). The World Bank (1998) linked knowledge to light and argued that it was weightless and intangible, yet it travelled easily round the world and enlightened people. Knowledge was deemed to be the most important factor influencing livelihoods, by bringing to light preferences, informing markets and illuminating economic transactions (The World Bank, 1998). It has been described as a primary source of competitive advantage (Zack, 1999; von Krogh, Ichijo and Nonaka, 2000; Awad and Ghaziri, 2004), as a catalyst for development (Chapman and Slaymaker, 2002), an accelerator of development and as a resource for addressing poverty (Mchombu, 2007).

Ferreira and Neto (2005) viewed knowledge as a public good associated with value and wealth. They contended that knowledge should be optimised through sharing, using and growing of more knowledge. Awad and Ghaziri (2004) shared similar views and considered knowledge to be social and not private. Once knowledge was relayed to others, it became part of the real-life experience of the person sharing it (Awad and Ghaziri, 2004). These assertions explain why knowledge is perceived to be the most valuable asset in today's world (Oettie and Koelle, 2003) and the ingredient that guides action towards sustainable development (Van Kerkhoff and Lebel, 2006). A review by Van Kerkhoff and Lebel (2006) showed that research-based knowledge from coalitions of actors, including researchers and practitioners, was linked with actions. In line with this argument, Jones (2006) emphasised that increases in agricultural production come from the application of new knowledge and innovations.

Shan *et al.* (2013), drawing from Nonaka and Takeuchi (1995)'s Knowledge Creation Theory, studied the impact of quality management practices on the knowledge creation process in the Chinese aviation industry, using a comprehensive literature review and field survey. The results showed that employee training, employee involvement, product design, benchmarking and vision statement have significant direct impact on the knowledge creation process, while other quality management practices such as top management support, customer focus, supplier quality management, quality information and recognition and rewards, do not have a direct impact on knowledge creation. The findings further stated that the use of cross-functional teams enable employees to share ideas in light of their experience and promote the sharing of tacit knowledge. Zakaria and Nagata (2010), in a study informed by the success and sustainability of the Japanese agriculture, examined the preferences and roles played by extension advisors in relation to knowledge creation and sharing among advisors, farmers and other stakeholders using interviews with 11 principal and senior extension advisors and consultants from different prefectures and organisations, as well as questionnaires from 135 extension advisors in the Ibaraki Prefecture, Japan. The results showed that the Japanese agricultural agencies are actively involved in facilitating integrated knowledge creation and sharing initiatives within their organisations. The extension advisors, as intermediaries and catalysts, are the key links between farmers and the relevant agencies in terms of providing personalised and need-based information for decision-making by all parties concerned.

Jing *et al.* (2009) studied knowledge creation in academia and research institutes, in which two surveys and case studies were carried out to achieve the research purpose at the Japan Advanced Institute of Science and Technology (JAIST). The first survey focused on KM in academia and investigated the current KM situations, special and diverse requirements from researchers. The second survey concentrated on supporting the creative processes of academic research and investigated which aspects of knowledge creation processes should be supported in particular. The findings from the first survey showed the KM obstacles reflected on various aspects: technological support, the people involved in creation activities, laboratory cultural, and so on. The results of the second survey helped the researchers to understand what aspects of the knowledge creation processes should be given more attention and support. The practical solutions are presented aimed at improving the creative environment for scientific knowledge creation. However, with respect to the survey results, it is suggested that a creative environment in academia should be enhanced from both ‘soft’ and ‘hard’ aspects under the guidelines of a systems thinking framework for KM in scientific labs. From the soft side, by using personalisation strategies, a knowledge-sharing culture has to be built in labs to facilitate scientific communication, debate and teamwork and from the hard side, by using technology strategies.

In assessing agricultural knowledge production from farmers' perspectives, Koutsouris and Papadopoulos (1998) stipulated that local knowledge was a requirement for understanding the complex farming systems of farmers. Although rural people‘s knowledge was, in the past, perceived to be primitive, unscientific and wrong, Scoones and Thompson (1993) and Warren (1991) felt that local knowledge was necessary for solving local problems. Supporting this argument, Oettie and Koelle (2003) pointed out that rural communities have a great strength - their local knowledge. They know about medicinal plants, environmental management and sustainable traditional agricultural practices. As observed by Hoffmann, Probst and Christinck (2007), farmers have been developing agricultural practices and innovations without the contributions of modern science. It is indeed acknowledged that farmers' local knowledge was gaining importance (Warren 1991; de Villiers 1996; Von Liebenstein 2000; McDowell 2004).

The World Bank (2010) pointed out some good practices, such as zero tillage and biochar, which were beneficial to farmers and the environment that tapped on both local knowledge and external information. To concretise these arguments, in a study of regional development through knowledge creation in the organic agriculture of Mexico, Galindo (2007) illustrates how organic agriculture standards and the attractiveness of the market changed the rural setting by promoting knowledge creation and application in the field. The results of such knowledge generation are endogenous growth practices for people who otherwise abandon agriculture as a means of living. Learning, innovating and networking are requirements and outcomes of following and utilising organic standards.

Kaniki and Mphahlele (2002) state that local knowledge emanated from research conducted in an area which is unique to a given culture or society and is based on innovation and practical experimentation. Various authors (The World Bank, 1998; Koskinen, 2003; Sen, 2005; Waters-Bayer and Van Veldhuizen, 2005; Jain, 2006; Nwokeabi, 2006; Kohlbacher and Krahe, 2007; Mchombu, 2007, cited in Munyua, 2011) have shown that the culture of a community determines how local knowledge is shared and how it is communicated (Styhre, 2003). Mchombu (2007) explained that local knowledge is part of the culture and heritage of the community. Using local people's knowledge could thus ensure success in development (Brokensha, Warren and Werner, 1980). Millar (2004) pointed out that, despite the many generations of colonial influence in Africa, decisions about agriculture, natural resources management (NRM) and health are heavily dependent on local traditions and cultures. This knowledge is passed on to younger generations by earlier generations, to guide decision-making, problem-solving, innovation and understanding (Stefano *et al.,* 2005). Nevertheless, Briggs (2005) contended that as a unitary knowledge, local knowledge had not quite attained the social and economic progress it was expected to attain among peasants and small-scale farmers.

Skyrme (2011) believed that knowledge gains more value when it is shared. Equally, rural communities have emphasised that it is very important to have information that you know, but you have to share it with others to enrich them (Leach, 2001). Probst, Raub and Romhardt (2000) acknowledged that the sharing of knowledge was crucial in ensuring survival and competitiveness. In this regard, traditional societies have nurtured their own knowledge systems in diverse spheres such as botany, meteorology, health and agriculture (Von Liebenstein, 2000). Communities have used this knowledge for decision-making on food security, human and animal health, education and natural resources management (Gorjestani, 2000). Mudege (2005) felt that agricultural knowledge was primarily social and its production was a social process; thus, gender dynamics, politics, power, conflicts, resistance, religious beliefs and government policies determined the production and socialisation of this knowledge in Zimbabwe. Review of the related literature on knowledge production and generation in agricultural sector suggests availability of literature globally. In this regard, some of the literature emanated from Japan (Jing *et al.,* 2009; Zakaria and Nagata, 2010); Mexico (Galindo, 2007); Zimbabwe (Mudege, 2005); Nigeria (Nicke and Ayola, 2004); The World Bank (2010); China (Shan *et al.,* 2013). It is evident from this review that few related works are found in the context of Nigeria. However, this paucity of literature has been alleviated by research questions 1 and 2 of the present study, namely What type of knowledge is generated by the Nigerian agricultural research institutes? and What is the extent of knowledge production by the research institutes?

3.3 Knowledge management strategies in agricultural research

Successful knowledge strategies in the 21st Century depend on whether or not organisations can link their business strategies to their knowledge requirements. This articulation is vital for allocating resources and capabilities for explaining and leveraging knowledge (Madalina, 2010). Ajaikaiye and Olusola (2003) observed that the knowledge system of any progressive society performs a pivotal function in its development. However, they note that "in spite of this recognition, the attention given to Nigeria's knowledge system has been weak and unstable, and has therefore affected its effectiveness and utilization." The challenge for institutions and countries is thus to determine and develop organisational practices, principles, guidelines and approaches on how knowledge can be created, harnessed, shared, tracked and distributed among government agencies, research communities and the public (Riley, 2003).

According to Jasimuddin (2008), the emergence of KM discipline has coincided with the development of the global knowledge-based economy, in which emphasis has been shifted from traditional factors of production, namely capital, land and labour, to knowledge. Parallel to this, Drucker (1992) suggests that classical factors are becoming secondary to knowledge as the primary resource for the economy. Several researchers (Despres and Hitrop, 1995; Neef, 1999; Davenport and Prusak, 1998; Day, 1994; Edvinsson and Sullivan, 1996; Davenport and Bibby, 1999) pointed out that the effective management of knowledge is becoming a critical ingredient for organisations seeking to ensure sustainable strategic competitive advantages. Davenport and Bibby (1999), for example, stressed that in the knowledge-based economy competitiveness is increasingly based upon access to knowledge in the form of skills and capabilities. In this knowledge economy, the number of knowledge-based and knowledge-enabling organisations that consider intellectual capital as a prime source is increasing (Katz, 1980; Roelof, 1999; Hargreaves, 1999; Smith, 2003; McElroy, 2000; Bassi, 1997; Riley, 1998). It is believed that staff members own the tools of production through the knowledge they possess (Kinnear and Sutherland, 2000). This increasing awareness of the value of knowledge embedded in experiences, skills and abilities of people has become an emerging discourse known as knowledge management (Todd, 1999).

The success of organisations (such as agricultural research institutes) in the post-industrial world seemingly lies more in their intellectual abilities than in their physical assets (Hargreaves, 1999; Bassi, 1997; Riley, 1998). This requires the transformation of personal knowledge into institutional knowledge that can be widely shared throughout the institution and appropriately applied (Bryans and Smith, 2000). The acquisition of knowledge and skills can be seen as an investment in the future (Robinson and Ellis, 1999). In an empirical study, Claudia and Marc (2010) investigated KM approaches and strategies from two different angles. First, they presented case studies of the United Nations Development Program, the UN Economic Commission for Asia and the Pacific, the World Bank, the International Atomic Energy Agency, the OECD and the European Commission. Second, they evaluated the progress of the respective approaches by using common test criteria for KM implementation established in the literature. It was found that all the institutions covered in this contribution have passed the stage of information management and have put active knowledge management systems in place. However, a structured and systematic management of implicit and external knowledge can be found, to a lesser extent. It was established that KM strategies like advocacy and learning, institutionalising KM have been put in place in the organisations.

Emanuele *et al.* (2004) studied knowledge management practices in four Italian non-profit organisations (NPOs), namely Consorzio Nazionale Della Cooperazione Sociale, Gino Matterelli, Foundazione IDEA, Societa San Vincenzo de Paoli, and Associazione Per il Bambino in Ospedale, using semi-interviews on 20 employees and managers to collect data. The findings show that knowledge required to both co-ordinate and manage the human resources and activities/process is explicit and shared in all the NPOs, but in IDEA it is individually-held. The study highlights the tendency of NPOs to maintain knowledge at an implicit and individual level, even when knowledge could be codified and shared within the network. The case analysis further confirms the initial consideration that KM in an average Italian NPO can be exploited to cope with challenges of excellent achievement and the quest for a high degree of effectiveness and efficiency can be supported and fostered by the introduction of *adhoc* KM solutions.

Mario and Fatima (2011) carried out empirical studies using survey methodology with a sample of 111 Spanish companies belonging to innovative industries. The findings provide evidence of a moderating effect of knowledge-centred culture, knowledge-oriented leadership and knowledge-centred HR practices in the relationship between knowledge exploration and exploitation practices and innovation outcomes of companies. In line with previous literature, it is suggested that, although KM practices are important on their own for innovation purposes, when certain enablers - organisational factors to overcome human barriers to KM - are properly established, the innovation capacity of the firm can be more successfully exploited. The results of Mario and Fatima (2011) study suggest that managers should pay attention to knowledge exploration and exploitation practices, along with several organisational enablers in order to achieve high levels of innovation results for the company. These result corroborated a study by Daniel and Fernando (2006) on 222 Spanish firms in the biotechnology and telecommunications industries. The results showed how the firms that adopted knowledge management practices obtained better results than their competitors. The study concluded that these practices have a positive incidence on firm performance.

Coyte *et al.* (2012) in a single case study, examined processes used to control the management of knowledge resources in small and medium enterprises (SMEs) in the economic sector of Australia and to compare the findings with the underlying assumptions and prescriptions of intellectual capital guidelines designed for SMEs. It was found that Tech Ltd's knowledge development processes resulted in substantial relational capital, built on its licence with Scand Co. and its market reputation achieved through the provision of high quality-products and service delivery. It further revealed that informal, intensive dialogue-based processes, structured by an overriding management philosophy, governed by strategisation and the management of knowledge resources were the functional KM initiatives and strategies for the enterprises. These governance processes were affected by a combination of formal and informal controls and serendipitous outcomes. An important discovery was the culture of teamwork across all employees and the open communication and accessibility to senior managers. It was also evident from the case study that value from knowledge resource management could not be fully realised, unless sufficient resources were available to harvest that knowledge. Consistent with findings of the preceding studies on the impact of KM strategies and practices in organisations, Ajay and Hans (2013), in an empirical study, conducted in a large thermal power generation organisation used data gathered from 210 middle and senior managers who were employed in different projects across the country to investigate the impact of the cognitive styles of leaders on knowledge management practices in a public sector organization in India. The results of exploratory factor analysis showed three significant factors of cognitive styles, namely radical, innovative-collaborator and adaptor. The results showed the relevance of the adaptor style of thinking in promoting knowledge management practices, which is consistent with the prevailing public sector work norms in India, which do not support any radical changes in their ways of working and solving problems.

Soliman (2003), in an empirical study titled ‘Role of the public and knowledge management as determinants of environmental policy formulation in developing countries: the case of Egypt’ addressed the questions of who is the public, how and when do they influence policy formulation, and whether or not KM has an impact on this role. It looks at the process of environmental policy formulation in developing countries as being similar to the diffusion of an innovation and develops a comprehensive framework, or adapted model, for how the environmental policy formulation process is likely to proceed in developing countries. The results showed that, although the role of the public is a significant factor in environmental policy formulation, it is KM that has a greater impact on the final outcome and speed of effective implementation.

Munyua and Stilwell (2013) in a study carried out in Kirinyaga district, Kenya, investigated how sense-making theory and methodology can be used to assess the use of local agricultural and external knowledge strategies by small-scale farmers and its effects on small-scale agriculture. They found that two knowledge systems, the local knowledge system and the external or scientific knowledge system, were dominant. The two systems were synergistic and small-scale farmers had mixed them into their farming activities. Blending systems improve communication, livelihoods and economies within local communities, and increase their participation in development. They found that a significant number of SMEs used combined external agricultural information and local knowledge strategies, which formed a third knowledge system. This third system required the validation of the farmers' innovations and documentation of the knowledge for wider dissemination. They recommended that information providers should adopt policies that promote the use of the three knowledge systems and strategies by small-scale farmers. Ndoro (2011) examined KM systems and strategies applied by extension workers supporting community gardens in the uMgungundlovu district municipality in KwaZulu-Natal. Findings revealed that the extension workers had the potential KM methods and strategies in place, such as departmental meetings that were not, however, efficiently used for managing knowledge.

Tarlton (1994), in a study of bureaucratic barriers and constraints to the utilisation of indigenous knowledge for sustainable agriculture in Sierra Leone, posited that local farmers' indigenous knowledge was not utilized as a solution to agricultural problems in Sierra Leone. The government seemed to suggest there were constraints to the use of local farmers' indigenous agricultural knowledge. The respondents consisted of 286 government and 130 non-government officials, 88 research and training officials and 75 extension agents. Data were analysed using qualitative and quantitative methods. Results showed there were several constraints to the use of local farmers' indigenous knowledge in agricultural development programmes. One such constraint was the belief that Western models of agricultural development would bring more agricultural and economic benefits to the country than local indigenous knowledge. The study recommended the need for appropriate government policies that would promote the use of local indigenous knowledge. Results also showed that there were policies, attitudinal and institutional barriers to the utilization of such indigenous knowledge in agricultural development programs. For example, 68% of governmental officials did not favour incorporating local indigenous knowledge in national agricultural policies in Sierra Leone.

Dweba and Mearns (2011) studied conserving indigenous knowledge as the key to the current and future use of traditional vegetables in a Xhosa village, Eastern Cape Province of South Africa. The study postulated that the transfer of indigenous knowledge on traditional vegetables would ensure the availability and utilisation of this important food source for resource-poor rural communities. Findings revealed that, although traditional vegetables were readily available, there was a decline in the use of traditional vegetables in the village. Since the loss of associated indigenous knowledge was a reality, and in view of the negative attitude towards traditional vegetables, the future use of this valuable food source was threatened.

Lwoga (2011) examined KM approaches in managing agricultural indigenous and exogenous knowledge in Tanzania, using semi-structured interviews and questionnaires to collect qualitative and quantitative data from 181 farmers in six districts. The findings indicated that both indigenous and exogenous knowledge was acquired and shared in different contexts. IK was shared within a local, small and spontaneous network, while exogenous knowledge was shared in a wide context, where formal sources of knowledge focused on disseminating exogenous knowledge more than IK. Policies, a legal framework, ICTs and culture determined access to knowledge in the communities. Dawoe *et al.* (2012) studied farmers' local knowledge of soil fertility and management in the Ashanti region of Ghana. The findings revealed that farmers' local knowledge of soil fertility and management strategies played a significant role in fertility maintenance of farmlands and also contributed to the participatory development of interventions to sustain farm productivity.

Addom (2010), in a PhD study titled 'Knowledge brokering in the digital age: the case of an agricultural innovation system', sought to understand the phenomenon of knowledge creation and sharing within the agricultural innovation system of Ghana. In order to understand this complex phenomenon of knowledge generation and sharing between and among the stakeholders within the agricultural innovation system, interview and focus group discussion techniques were used to gather data from multiple sources and multiple respondents. The results showed two sources of knowledge generation (local and scientific); wide gaps of knowledge barriers between the knowledge sources; and the presence of intermediary organisations in the system. Bijaya and Uday (2011) carried out an investigation on KM strategies in two information technology (IT) organisations in India, where qualitative data were obtained from the two organisations. Four themes of KM strategies emerged after the data were subjected to grounded theory analysis. These are knowledge creation, knowledge sharing, knowledge up-gradation and knowledge retention. The two sample organisations were compared on these dimensions. Two concepts emerged from this comparison, namely, knowledge enabler, which means knowledge creation in the form of self-learning, rewards for knowledge creation, induction training, decentralised and multi-channel knowledge sharing, knowledge up-gradation by way of job rotation, external and internal benchmarking, a mandatory knowledge transfer process and multilevel knowledge retention controls and knowledge inhibitors, which is top-driven knowledge sharing which restricts individuals' initiative, responsibility and accountability. External benchmarking of knowledge is less and mostly in-house knowledge up-gradation training and limited ways of knowledge retention.

Jasimuddin (2008) carried out an in-depth case study of knowledge strategies in a UK-based group within a high-tech global corporation which was purposively selected for data collection.

The research sought to address the way in which knowledge was being managed among the members of a large corporation. The results showed the deficiency of a single KM strategy, thereby suggesting the need for a hybrid strategy which recognises the interplay between the soft and hard mechanisms. Martina *et al.* (2008) examined the relationship between business and KM strategy and the success of the KM initiatives using 11 German and Swiss companies. The findings suggest a relationship between the success of knowledge management and the alignment of KM and business strategy. The study also showed that an organisation whose business strategy requires process efficiency should rely primarily on a codification strategy. In contrast, an organisation whose business strategy requires product/process innovation should rely primarily on a personalisation strategy. The study found that the most successful knowledge management projects were driven by a strong business need, with the goal to add value to the organisational unit operations. These findings reaffirmed the claims by Jasimuddin (2008) about the need for organisations to adopt hybridised KM strategies for effective performance.

In a related study De Marchi and Grandinetti, (2013) investigated how green innovators addressed the knowledge needs when initiating a sustainability path, comparing their knowledge strategies with those of non-green innovators using data from the 2008 Italian Community Innovation Survey (CIS). The results suggest that the development of EIs entails a higher recourse to external knowledge, in the form of the use of external sources of information, acquiring R&D from external firms and co-operation. Relationships with partners that do not belong to the supply chain - including KIBS, universities, research institutions and competitors – were found far more important than for other innovations. On the contrary, differences between the two categories were less marked when it came to investments in internal knowledge resources. Finally, proactive environmental innovators had very different knowledge strategies than reactive ones, which resembled non-green innovators.

Extensive literature has been reviewed on KM strategies and agricultural research. These include Nigeria (Ajaikaiye and Olusola, 2003); the United Nations (Claudia and Marc, 2010); Italy (Emanuele *et al.,* 2004; De Marchi and Grandinetti, 2013; Spain (Mario and Fatima, 2011; Daniel and Fernando, 2006); Europe (Coyte *et al.,* 2012); India (Ajay and Hans, 2013; Bijaya and Uday, 2011); Egypt (Soliman, 2003); South Africa (Noeth, 2004; Dweba and Mearns, 2011); Kenya (Munyua and Stilwell, 2013); Sierra Leone (Tarlton, 1994); Tanzania (Lwoga, 2011);

Ghana (Dowoe *et al.,* 2012; Addom, 2010); UK (Jasimuddin, 2008); and Germany (Martina et al., 2008). These results show few related works from Nigeria, which suggest a gaps in the literature on KM strategies and agricultural research. This gap in the literature was addressed by research question 3 of the present study, namely What knowledge management strategies are used by the research institutes to drive research and innovation?

3.3.1 Knowledge management processes

Knowledge management involves the processes which produce or discover knowledge and manage the use and distribution of knowledge inside and among organisations (Darroch, 2003; Kiessling *et al.,* 2009). Darroch (2003) states that knowledge consists of three components: acquisition, dissemination and use or responsiveness. These components of KM are dependent on each other. The effectiveness of the three components in KM requires learning to have taken place to enable individuals to acquire, disseminate and use knowledge. The knowledge management processes involve a learning aspect. The process facilitates exchange and sharing, and institutionalising of learning that is ongoing inside the organisation (Lopez *et al.,* 2004; Call, 2005). Nevis, DiBella and Gould (1995) divide knowledge processing activities into three steps namely knowledge acquisition, knowledge sharing and knowledge utilisation. These processes are key factors in a successful organisation (Zhang *et al.,* 2006). Instead of knowledge acquisition alone, the term knowledge accumulation will be used throughout the article, as it is a more comprehensive concept than knowledge acquisition alone. In line with the main thrust of the present study, Ruggles (1998) proposed eight major categories of knowledge-focused activities for organisations which would serve as the epitome of knowledge production and management activities. These include:

1- Generating new knowledge
2- Accessing valuable knowledge from outside sources
3- Using accessible knowledge in decision making
4- Embedding knowledge in processes, products and/or services
5- Representing knowledge in documents, databases and software
6- Facilitating knowledge growth through culture and incentives
7- Transferring existing knowledge into other parts of the organisation

8-Measuring the value of knowledge assets and/or impact of knowledge management

3.3.1.1 Knowledge generation/accumulation

According to Gupta and Govindarajan (2000), knowledge accumulation consists of knowledge creation, knowledge acquisition and knowledge retention. Knowledge creation refers to the interaction between tacit and explicit knowledge, rather than tacit or explicit knowledge acting separately (Hussi, 2004). Through this interaction, innovations and organisational knowledge are created. By finding new and useful ideas and solutions (Marakas, 1999), the company develops new, or replaces old, contents within the organisation's tacit and explicit knowledge base (Pentland, 1995). Organisations also acquire knowledge from outside sources (Hussi, 2004), through individual learning, scanning of the external and internal environment, hiring new employees or buying companies with the required knowledge (Lim Klobas, 2000). Knowledge retention, the last step of knowledge accumulation, includes all activities that preserve knowledge and allow it to remain in the system once introduced (Newman and Conrad, 1999). It refers to minimising the loss of proprietary knowledge (Gupta and Govindarajan, 2000).

3.3.1.2 Knowledge sharing

Knowledge sharing involves the sharing of organisationally relevant information, ideas, suggestions and expertise among the employees of the organisation (Bartol and Srivistava, 2002). This exchange can occur both informally, in places like the corridor, and formally, in meetings, seminars and presentations (Bircham, 2003). As the knowledge an organisation possesses is considered to be a resource leading to competitive advantage (McEvily and Chakravarthy, 2002), management is inclined to exploit the knowledge of its employees to its own benefit (Bircham, 2003), by encouraging knowledge sharing. The processes through which knowledge is shared determine the success of organisational learning (Cummings, 2003). In order for an organisation to utilise knowledge assets, knowledge must move smoothly through organisations (Lin *et al.,* 2003). This can be achieved only if people are motivated to access and share information and to transform the information they acquire into knowledge (Brand, 1998). Organisations must therefore strongly motivate, rather than just encourage, their employees to share their knowledge (Bock and Kim, 2002). The factors affecting sharing and transfer of knowledge in an organisation concern the motivation for sharing (Kalling, 2003), knowledge tacitness (Argote and Ingram, 2000; McEvily and Chakravarthy, 2002), the ability of the source to share (Foss and Pedersen, 2002) and the ability of the recipient to accept knowledge.

3.3.1.3 Knowledge utilisation

Knowledge utilisation is the effective use of knowledge (Lim and Klobas, 2000). If the receiver is aware of the knowledge, makes sense of the knowledge received and has the freedom to apply it (Lim and Klobas, 2000), knowledge can be utilised. The organisational knowledge that has been transmitted between senders and receivers needs to be integrated into a company's products, processes and services (Bhatt, 2001). The ability of the recipient to accept knowledge is one of the factors determining whether or not the act of knowledge sharing has been successful (Gupta and Govindarajan, 2000) and it is far from certain that the recipient of knowledge uses the knowledge received (Bircham, 2003). To speak about knowledge transfer, the transferred knowledge elements of the source must have been re-created in the recipient. Only if the recipient obtains full ownership of the incoming knowledge does he become committed to it (Cummings, 2003). In this case, he makes use of the received knowledge by way of developing a new product or process, or by making a decision. One of the barriers for knowledge utiliaation is the fact that knowledge from others is looked upon suspiciously (Bock and Kim, 2002). Just as individuals have a positive or negative attitude toward sharing the knowledge they own, potential recipients may also have an attitude toward the knowledge they receive (Bircham, 2003). Factors such as the capacity of the recipient to absorb the incoming knowledge and his/her familiarity with the area of knowledge being shared may affect this ability (So and Bolloju, 2005) and willingness to understand and accept the knowledge being provided (Bircham, 2003). Attitudes like the 'not-invented here' syndrome (Katz and Allen, 1982) or doubts about the trustworthiness of the source (Bircham, 2003) may impede the willingness of the recipient to accept the incoming knowledge.

3.4 Knowledge dissemination in agricultural research

Knowledge contents intermingle in a spiral form with each other, creating new knowledge. According to Nonaka (1991), the individual is always the source of new knowledge. Making this new knowledge available to everyone in the company is a vital aspect of the knowledge-creating company. Individuals are not there to receive new knowledge passively; they engage with it and actively interpret the knowledge to suit their circumstances and viewpoints. Consequently, what makes sense in a particular context may change or lose meaning when communicated to others in other situations. According to Nonaka (1991), there is a continued modification of meaning as knowledge is shared within an organisation. Amayah (2013) examined the determinants of knowledge sharing in public sector organisation in the U.S., using quantitative research. Community-related considerations, normative considerations and personal benefits were three motivators found to have a unique contribution to the variance in knowledge -haring. According to the study, enablers of knowledge-sharing include social interaction, rewards and organisational support.

Knowledge-sharing is vital for the survival of an organisation in a dynamic economy. Shared knowledge keeps the organisation alive and is used as a reference for future use by employees of the organisation. Shared knowledge allows learning and re-examination of the knowledge that was created, which is necessary for the organisation to have a competitive advantage (Munyua, 2011). Employees thus become innovative and there is quick responsiveness by the organization to new situations. Knowledge-sharing amongst employees contributes to the creation of new knowledge in the organisation, which is a critical activity that contributes to the success of the organisation as new knowledge becomes available for everyone in the organisation to take advantage of. This may lead to innovative initiatives within the organization, giving the company an advantage in the competitive world (Nonaka, 1991). As knowledge is shared, people are no longer mere receivers of the new knowledge; instead, they become innovative actors with the new knowledge which makes it more context-specific to different situations.

According to Niang (1995), the transfer of technology was synonymous with the transfer of knowledge and expertise. According to Davenport and Prusak (1997), the key purpose of information is to inform people. However, knowledge and information resources can only be drawn on for use if they are communicated and exchanged to satisfy the information needs of the recipient (Drucker, 1999; Vikas Nath, 2000). As pointed out by Powell (2003) it is the flow and exchange of information that determine the use of information and the creation of value. Dervin (2003) felt that information can be viewed as a thing that can be manufactured, processed or transmitted and as construction. Both approaches are useful to informing human beings. Agricultural knowledge and information flows could be achieved through various channels including private sector firms, extension agents, print and electronic media, universities, NGOs, agro-industries and suppliers of equipment and inputs (Berdegué and Escobar, 2001). As stressed by Smith (2005), there is no single right way of sharing knowledge, but, rather, knowledge sharing activities are determined by how individuals and groups feel about the process and the network of people they socialise with.

The social ecology approach, for example, which emphasises the perceptions of individual farmers within the environment at multiple levels and the interactions between people and their surrounding social environment places emphasis on the role of individuals, groups and institutions in the flow of information and their cumulative impact on the community (Binder, 1972; Stokols, 1996; Dimara *et al.,* 2003). Interactions between group members (e.g. farmers' societies and co-operative organisations) create a support network, which is strengthened and guided by the shared objectives of the group, participation in group activities and rules of the group (Kilpatrick and Bell, 1998). While interactive methods such as friends, community radio and discussions permit the reader or listener to respond, non-interactive methods, for example books, do not provide for feedback (Rivera *et al.,* 2005). Different communication channels have been used to communicate agricultural information and knowledge to farmers, including traditional channels (Mundy and Compton 1995; Karamagi Akiiki 2006); through study tours and exchange visits (Noordin *et al.,* 2001; Gianatti and Carmody, 2007); and through ICTs (Richardson, 1996; 1999; 2006; Alavi and Leidner, 2001; Del Castello and Braun, 2006), which have transformed the manner in which information and knowledge is shared.

ICTs facilitate the capturing, processing, storing and communication of information (Heeks, 1999; Juma and Yee Cheong, 2005) and the capture, processing, documenting, storage and sharing of knowledge. Farmers use conventional (older) ICTs (print media, radio, television, video, fax) and modern ICTs (WorldSpace radio, computers, internet, web-based applications, cellular phones, CD-ROM) concurrently to allow different community target groups to select the communication tools that suit their needs (Colle and Roman, 2003; Wild, 2006, cited in Munyua, 2011) and the type of information needed. For instance, in Nigeria today government and farmers share and disseminate information via mobile telephones; government informs farmers about the availability of farm implements, fertilizer, seeds and seedlings, while farmers seek clarification on many issues about farming and farming techniques, and farmers draw the attention of extension workers to any threat to the development of the agricultural system in their locality. At global level, Farmers' Friend is an innovation of Google in collaboration with the Grameen Village Program. WorldSpace radio is also being used to deliver agricultural information and knowledge to disadvantaged rural communities (Mchombu *et al.,* 2001; Munyua, 2007; CABI, 2014).

In a study to assess the impact of technology on knowledge sharing in transnational organisations using standard literature reviews, plus illustrations from case organisations, Coakes (2006) demonstrated that transnational organisations have specific issues relating to space and time, and increasingly virtuality, in their working practices. Technology can assist in alleviating these issues and can provide the organisations with ways to share and distribute knowledge throughout their processes, sites and workforces. Successful knowledge management, however, continues to need a sociotechnical approach, where the social aspects of knowledge creation, storage and sharing need to be considered alongside the technical. Sociotechnical theory tells us we must importantly consider people, tasks, processes, and the environment (both internal and external), when considering how best to implement technology into our organisations.

In a divergent argument, Kang and Kim (2013), in a study of knowledge transfer, used hierarchical multiple regression to analyse survey responses from 337 R&D employees. The results of the study revealed that facilitating social networks among employees is not enough for active knowledge transfer. Each employee should be guided to connect to the right experts who have the right knowledge (i.e. embedded resources) for his or her job. This is consistent with one of the tenets of KM (learning by doing) and the source of tacit knowledge in organisations. Storga *et al.* (2013) used recursive analysis of email interactions, network expansion and network configuration to study electronic knowledge transfer in a non-governmental international organisation. The results of the study indicate that content structure of electronic knowledge networks exhibits hierarchical and centralised tendencies. The social network analysis results suggest that an international non-governmental organisation (INGO) exhibits non-hierarchical and decentralised structure of the individuals contributing to the discussion lists.

To investigate the factors that affect knowledge transfer and sharing in public sector organisations, Amayah (2013) used a quantitative research method. The findings were that community-related considerations, normative considerations and personal benefits were three motivators found to have a unique contribution to the variance in knowledge sharing. The following enablers had a significant main effect on knowledge sharing: social interaction, rewards and organisational support. Two barriers, degree of courage and degree of empathy, which measured the organisational climate, were found to have a significant effect on knowledge sharing. The interaction of normative consideration with social interaction, personal benefit with organisational support and normative considerations with degree of courage had a moderating effect on the relationship between motivating factors and knowledge sharing. Connell and Voola (2013) examined how - and whether - members of an industry cluster share knowledge through networking as a means of improving competitive advantage and, in particular, whether trust is present in the knowledge-sharing process. The study used three surveys utilising a relationship marketing orientation (RMO) that were conducted at intervals (in 2004, 2008 and 2010), in addition to interviews with key cluster members, which were also conducted over a seven-year period. The results showed that knowledge sharing and integration were found to mediate the relationship between RMO and competitive advantage in 2004 and 2010, but not in 2008. Lower mean scores for trust were found in 2008. To further establish this argument, Mura *et al.* (2013) used six hypotheses from the literature, grounded and tested among 198 employees of four hospices and palliative care organisations (H&PCOs) for dying cancer patients to study the relevance of engaging employees in knowledge-sharing behaviours in order to improve current operations. The study had three main results. First, the authors found a positive role of knowledge-sharing behaviours in affecting sharers' innovativeness, in terms of propensity and capacity to promote and implement new ideas. Second, sharing best practices and sharing mistakes are two distinct drivers of individuals' innovativeness. Third, individuals' perceptions of social capital have a relevant moderation effect on the linkage between knowledge sharing and innovative behaviour.

Finally, according to Opondo *et al.* (2006), farmers often make decisions, assess their performance, monitor and improve their activities, address power relations and improve problem-solving using knowledge acquired from outside sources such as research institutes and universities. As explained by Backus *et al.* (1997), farming is a risky venture, with many uncertainties, but is profitable. Farmers thus need to constantly make decisions based on changes in their practices and farming systems (Van den Ban, 1998). Del Castillo and Braun (2006) and Kahan (2008) reiterated that subsistence farmers face serious risks in their farming activities, because their livelihoods are dependent on how much they produce. Farmers needed information and skills on alternative options, assurance and markets in order to make decisions that mitigate risks. Farmers also use information to solve problems (Warren, 1991), and as aptly expressed by Abid (1995) and Meyer (2005), information is the precursor to problem-solving. The knowledge required to solve problems depended on personal interpretation, based on an individual‘s ideas, perceptions and experience, and their skills and ability and not so much a model solution (Scoones and Thompson, 1993; Little *et al.,* 2000; Williamson *et al.,* 2003).

Based on the above, farmers in developing countries, particularly Nigeria, need to access the required information and knowledge in order to enhance and boost their farming activities, thereby restoring the past glory of the country’s agricultural fortune. Nigerian agricultural research institutes are vital in this effort, through their research and development activities, extension and training services. This is because farmers need to learn about improved farming techniques and market needs. Science and innovation provide solutions based on scientific and local knowledge and information (Galindo, 2007). According to Reij and Waters-Bayer (2001), innovations by farmers demonstrate how local resources can be used to exploit opportunities and solve problems. For example, a study by Matovelo, Msuya and De Smet (2006) demonstrated that farmers used external information for innovation and that most farmers desired to have information on different agricultural innovations in order to improve their farming practices. Wall (2006) found that power and culture determined the creation, sharing and use of agricultural knowledge in rural Uzbekistan, while, in a Guatemala village, Siebers (2003) found that culture and power determined the knowledge-sharing processes and integration of the external knowledge into the local knowledge system.

Review of the literature on knowledge dissemination in agricultural research covers the global and continental levels. These include the U.S.A. (Amayah, 2013); Multi-National Organizations (Coakes, 2006; Connell and Voola, 2013; Storga *et al.,* 2013); Italy (Mura *et al.,* 2013); Asia (Kang and Kim, 2013); Uzbekistan (Wall, 2006); and Guatemala (Siebers, 2003). This review suggests unavailability of related works in Nigeria and about Nigeria, which the present study seeks to address through the research question 4, namely How is the knowledge generated disseminated?

3.5 Factors influencing knowledge management adoption in agricultural research Institutes

KM in organisations is driven by various levels of employees through cross-functional project teams, which enable sharing of knowledge in both formal and informal ways. In knowledge-intensive organisations such as agricultural research institutes, the knowledge management crew is responsible for knowledge management activities (Nonaka and Takeuchi, 1995). The crew consists of knowledge officers (top management), who provide policy direction, knowledge engineers (middle management) who convert policy into workable units, and knowledge practitioners (lower level staff), who are at the front line of the knowledge creation business. Details concerning the role and responsibilities of these categories of staff are discussed.

3.5.1 Knowledge creation crew

Generally, knowledge creation and adoption in knowledge-creating organisations requires the participation of front-line employees, middle managers and top managers. Everyone in a knowledge-creating organisation is a knowledge creator. The value of any one person's contribution is determined less by his/her location in the organisational hierarchy than by the importance of the information she/he provides to the entire knowledge creating system. According to Nonaka and Takeuchi (1995), knowledge creation is the product of dynamic interaction among the following three players: (1) knowledge practitioners, (2) knowledge engineers, (3) knowledge officers.

3.5.1.1 Knowledge practitioners

The basic role of knowledge practitioners is the embodiment of knowledge. They accumulate, generate and update tacit and explicit knowledge, acting almost as a 'walking archive', on a day-to-day basis. Since most of them work at the front lines of the business, which means that they are constantly in direct touch with the outside world (e.g. extension agents), they can obtain access to the latest information on developments in the farming system, market, technology, or competition. The quality of knowledge that they accumulate and generate is determined by the quality of their direct experience at the front lines of day-to-day business. Thus, knowledge officers and knowledge engineers need to give them tasks that are as challenging and exploratory as possible.

According to Nonaka and Takeuchi (1995), knowledge practitioners are made up of two complementary groups namely ‘knowledge operators’ and ‘knowledge specialists’. Knowledge operators accumulate and generate rich tacit knowledge (through interaction with stakeholders such as farmers) in the form of experience-based, personal skills. They constantly interface with the realities of the various fields and accumulate tacit knowledge through personal experience, while the knowledge specialists accumulate, generate and update knowledge, but of a different kind from that which interests knowledge operators. Knowledge specialists mobilise well-structured explicit knowledge in the form of technical, scientific and other quantifiable data, the kind of knowledge that could be transmitted and stored on a computer. In this group are scientists in R&D, design engineers, software engineers, sales engineers and strategic planners.

According to Nonaka and Takeuchi (1995), knowledge practitioners should have the following qualifications: (1) they need to have a high intellectual standard; (2) they need to have a strong sense of commitment to re-create the world according to their own perspective; (3) they need to have a wide variety of experiences, both inside and outside the organisation; (4) they need to be skilled in carrying on a dialogue with customers as well as with colleagues within the organisation; and (5) they need to be open to carry out candid discussions, as well as debates with others.

3.5.1.2 Knowledge engineers

Knowledge engineers are the middle managers of a knowledge-creating organisation. They serve as a bridge between the visionary ideals of the top and the often chaotic market reality of those on the front line of business. They remake reality, or, to put it differently, engineer new knowledge according to the organisation’s vision. In remaking reality, knowledge engineers take the lead in converting knowledge. They facilitate all four modes of knowledge conversion, although they make their most significant mark in converting tacit images and perspectives into explicit concepts (i.e. externalization). They synthesise the tacit knowledge of both frontline employees and senior executives, make it explicit, and incorporate it into new technologies, products, or systems. Of course, this is not to say that they are not adept at ‘engineering’ the three other modes of knowledge conversion - socialisation, combination, and internalisation. In addition to knowledge conversion, knowledge engineers play two other key roles, both of which involve the creation of a knowledge spiral. The first is their role in facilitating a knowledge spiral along the epistemological dimension, across the different modes of knowledge conversion. The second is their role in facilitating another spiral along the ontological dimension, across different organisational levels. Knowledge created at the individual level can move up to the group level, then to the organisational level and sometimes up to the inter-organisational level.

According to Nonaka and Takeuchi (1995), knowledge engineers should possess the following qualifications: (1) they must be equipped with top-notch capabilities of project co-ordination and management; (2) they need to be skilled at coming up with hypotheses in order to create new concepts; (3) they need to have the ability to integrate various methodologies for knowledge creation; (4) they need to communicate skills to encourage dialogue among team members; (5) they should be proficient at employing metaphors in order to help others generate and articulate imagination; (6) they should engender trust among team members; and (7) they should have the ability to envision the future course of action based on an understanding of the past.

3.5.1.3 Knowledge officers

The basic role of knowledge officers, who are top or senior managers of the knowledge-creating organisation, is the management of the total organisational knowledge creation process at the corporate level. Knowledge officers produce and control the process on a hands-on basis, sometimes resorting to 'management by wandering around' (Nonaka and Takeuchi, 1995). Knowledge officers give knowledge-creating organizations a sense of direction by: (1) articulating grand concepts on what the organisation ought to be; (2) establishing a knowledge vision in the form of a corporate vision or policy statement; and (3) setting the standards for justifying the value of the knowledge that is being created.

Another role of knowledge officers is the establishment of a knowledge vision that defines the value system of the organisation. This value system evaluates, justifies and determines the quality of knowledge the organisation creates (Nonaka and Takeuchi, 1995). Knowledge officers should be aware that their aspirations and ideals determine the quality of knowledge the organisation creates. While the ideals of top management are important, on their own they are not enough; they need to foster a degree of personal commitment by other members of the knowledge-creating crew. To do so, an open-minded and equivocal vision, which is susceptible to a variety of interpretations, is preferable. A more equivocal vision gives members of the self-organising team the freedom and autonomy to set their goals, making them more committed to figuring out what the ideals of the top mean are. Knowledge officers are also responsible for justifying the value of knowledge that is constantly being developed by the crew. They need to decide strategically which efforts to support and develop. Applying these qualitative and quantitative criteria means essential truthfulness, beauty, goodness, efficiency, cost, or return on investment.

According to Nonaka and Takeuchi (1995), senior or top managers of a knowledge-creating organisation should ideally have the following characteristics to qualify as knowledge officers: (1) ability to articulate a knowledge vision in order to give the organisation's knowledge-creating activities a sense of direction; (2) capability to communicate the vision, as well as the corporate culture on which it is based, to project team members; (3) capability to justify the quality of the created knowledge based on organisational criteria or standards; (4) uncanny talent for selecting the right project leader; (5) willingness to create chaos within the project team by, for example, setting inordinately challenging goals; (6) skilfulness in interacting with team members on a hands-on basis and soliciting commitment from them; and (7) capability to direct and manage the total process of organisational knowledge-creation.

3.6 Knowledge management infrastructure

While the significance of knowledge work has been continuously increasing, it still represents a particularly challenging context from a productivity improvement point-of-view (Drucker, 1999; Haas and Hansen, 2007; Bosch-Sijtsema *et al.,* 2009 cited in Palvalin *et al.,* 2013). A key challenge is that many of the knowledge workers' tasks are labour-intensive, i.e. knowledge workers are required to use their personal work time to think, communicate, read and carry out other knowledge-related tasks. Knowledge work is a challenging and peculiar setting from a managerial perspective (Drucker, 1999). In the literature, various characterisations and classifications for knowledge work and knowledge-intensive organisations have been proposed (Kapyla *et al.,* 2011; Miles *et al.,* 1995; Starbuck, 1992; Pyoria, 2005; Von Nordenflycht, 2010).

Knowledge work and knowledge-intensive organisations are characterised by highly skilled and autonomous personnel, ambiguous work processes and intangible outputs (Pyoria, 2005).

3.6.1 ICTs and knowledge management

Information and communication technology (ICT) provides potential means for improving knowledge work productivity, for example, through helping knowledge workers perform certain routine (non-value-adding) tasks faster and through supporting knowledge-sharing among professionals (Ahuja *et al.,* 2009; Sigala, 2003). Companies are eager to purchase various ICT services in order to improve the productivity of their knowledge workers. The development of ICT has changed knowledge work significantly in recent decades. Technology allows many operations to be automated (Marsh and Flanagan 2000). At best, automation takes care of many routine tasks and people thus have additional time for more demanding tasks. Technology has also improved access to information (Shin, 2004; Marsh and Flanagan 2000; Ahuja *et al.,* 2009) and communication has become easier due to, for example, mobile phones and video conference calls. Furthermore, the increased use of ICT has improved the quality of information (Suwardy *et al.,* 2003).

Palvalin *et al.* (2013) studied the impact of ICT services on knowledge work using a literature review and a case study conducted in a medium-sized European teleoperator company. The findings show that ICT can be used to eliminate non-value-adding tasks or to make them more efficient. ICT can improve employee welfare, for example, through transforming the content of work by deleting unimportant activities. The empirical study showed that, contrary to the view presented in the prior literature, it does not seem *that* difficult to measure the impacts of ICT on knowledge work productivity. A key point in the measurement is the identification of case-specific impact factors, by examining the characteristics of the ICT service and the organisational setting. These findings confirmed the claims (Ahuja *et al.,* 2009; Norton, 1995; Rodrıguez Casal *et al.,* 2005; Sigala, 2003) about the impact and benefits of applying ICT to knowledge work.

3.6.2 Organizational culture and knowledge m anagement

KM is rooted in human experience (Oltra, 2005) and social context (Alavi *et al.,* 2005, cited in Nayir and Uzuncarsili, 2008). Managing it requires not only attention to the information technology, but even more to the people (Havens and Knapp, 1999) in that organisation. Organisational culture is one of the key parameters of successful knowledge management (Martin, 2000; Knapp and Yu, 1999) and can influence the procedures and influence of knowledge management (Chen and Lee, 2005). Organisational culture includes the values, beliefs, norms and expectations widely held in an organisation (Huber, 2001). It is affected by internal factors, such as the vision, mission and values of the company, the technology employed within the company, the organisational structure and the management style, as well as external factors such as the social environment of the organisation (Lemon and Sahota, 2003). Organisational culture is perhaps the most significant hurdle to effective knowledge management (Gold *et al.,* 2001). According to De Long and Fahey (2000), most managers recognize organisational culture as the most significant barrier to creating and leveraging knowledge assets, since culture shapes people's assumptions about what knowledge is important. Culture is also the basis for perceptions on which knowledge is organisational and which knowledge is individual. Culture also shapes the creation and adoption of new knowledge. Nayir and Uzuncarsili (2008) examined the impact of organisational culture on successful KM practices in Sarkuysan, a Turkish company producing electrolytic copper conductors and the leading company in the Turkish copper industry. They conducted several interviews with the top managers of the company. The results show that effective knowledge management practices, combined with a unique corporate culture, can enable companies to instill a lasting KM culture. The culture of Sarkuysan rests on the four main value pillars of storytelling, trust, continuity and loyalty.

3.7 Explicit knowledge versus tacit knowledge

KM authors divide and typify knowledge in different ways. For example, some authors differentiate technical and strategic types (Liebeskind, 1996). Grant (1996) proposes practical knowledge, intellectual knowledge (scientific, humanistic and cultural), pastime knowledge (news, gossip and stories) and undesired knowledge. Garvin (1998) and Brown and Duguid (2001) focus on issues related to problem-solving knowledge in work practices and knowledge associated with co-ordination and tactical issues. However, the more common characterisation of knowledge is tacit knowledge and explicit knowledge (Srikantiah and Koenig, 2000; Nonaka, 1994; Nonaka and Konno, 1998; Nonaka and Takeuchi, 1995; Cavusgil *et al.,* 2003). This division of knowledge into tacit knowledge and explicit knowledge is the most popular and relevant to the present study, as guided by the Nonaka and Takeuchi (1995) knowledge-creation theory.

3.7.1 Explicit knowledge

Codified knowledge may be defined as the value endowing meta-resource originating from thought, reflection, or experience that is expressed as information using systems of symbols. This definition considers codified knowledge to be shaped as a meta-resource 'abstracted, and incorporated in check-lists, manuals, blueprints and computer programs' (Zollo, 1998). The term ''codified knowledge'' is used to describe information to recognize that it originates from tacit knowledge (Saviotti, 2004). The unique value of codified knowledge lies in its eminent replicability (Teece, 2000). Codified knowledge, popularly known as explicit knowledge, has the unique attributes of being non-rivalrous and non-excludable (Langlois and Robertson, 1996; Saviotti, 2004). Unlike tacit knowledge, codified knowledge may be very inexpensively replicated, transferred and diffused (Boisot, 1998; Heiman and Nickerson, 2004; Romer, 1990). The codification of knowledge facilitates inexpensive intra-firm knowledge transfer, but also increases the risk of misappropriation outside the firm. Firm boundary decisions are thus strongly influenced by strategic consideration of the imitability and replicability of codified knowledge (Teece, 1998a).

Knowledge documents for example, represent a form of codified knowledge that is highly explicit, can originate either internally or externally and has been established as having an extended currency. This 'field of information (codified knowledge) can include statistics, maps, procedures, analyses . . .' (McDermott, 1999). While much codified knowledge can originate internally, 'such knowledge sources may lie outside the firm' (Zack, 1999). Knowledge documents can be traditional structured knowledge in text-based forms that include project reports, technical reports, research reports and publications. Alternatively, it can be in unstructured forms, which can include pictures, drawings, diagrams, presentations, audio and video clips, on-line manuals and tutorials. In this sense, knowledge documents may not be ''documents'' in the traditional sense, but must represent fully explicit knowledge with an extended currency of diverse types.

The strategy for knowledge documents is to achieve easy identification of relevant sources of knowledge that enhance learning. The codifications strategy presented by (Hansen *et al.,* 1999) identified the creation of ‘‘knowledge objects’’ that allows the re-use of codified knowledge without the need to contact the individual who originally developed the objects. The source of knowledge in this sense goes beyond the organisation’s human capital and into its suppliers, customers and published reports (e.g. Gartner reports, industry trends, competitive intelligence analysis, etc.). Search engines are a critical enabling technology for this, but must also provide intuitive taxonomies, nimble indexing and diverse search methods. The processes for using knowledge documents include cataloging, storage and retrieval methods. These processes must be designed to access both structured and unstructured knowledge in its many diverse forms. Although unstructured knowledge may exist within other KM strategies (especially Lessons Learned), the knowledge document would focus significantly on incorporating this type of knowledge alongside more traditional structured forms of knowledge. Finally, knowledge documents should also be obtainable both in summary and their complete original form. Since knowledge documents represent highly explicit knowledge, the organisation’s human capital should understand, be educated about and recognise standard locations for obtaining this form of knowledge, which could be a veritable working tool for organisations, especially research institutes. These knowledge documents in the agricultural research institutes include manuals/research guides, maps and blueprints.

3.7.2 Tacit knowledge

Tacit knowledge may be defined as the value-endowing meta-resource originating from thought, reflection, or experience that remains resident in the human mind. This definition considers tacit knowledge to be shaped as a meta-resource ‘held by a knowing agent’ (Boisot, 1998). An organisation’s members implicitly use this knowledge as they perform their skills, since it remains resident in the human mind (Choo, 2002). Tacit knowledge is an important resource of organisations, given that 42 percent of corporate knowledge is held within employees’ minds (Clarke and Rollo, 2001). This knowledge may be gained by experience that is often incommunicable and only evident as it is expressed or practised by its possessor (Spender, 1996). Tacit knowledge, for example, as practical skill or expertise permitting efficient execution, must be learned, acquired and accumulated through experience (Nelson and Winter, 1982; Winter, 1987). Tacit knowledge may also be considered procedural know-how (Kogut and Zander, 1992). It has the unique characteristic of being absolutely necessary to interpret and process the structured and formatted data sets that constitute codified knowledge (Boisot, 1998; Cowan *et al.,* 2000; David and Foray, 2002). It is also expensive to transfer and diffuse, requiring complex structures of interaction (Choo, 2002).

Exploring the significance of practice as an aspect of organisational knowledge, Nelson and Winter (1982) argued that much of the organization's knowledge is embedded in its practices in the form of routines and operating procedures. Huber (1991) stressed that a great deal of organisational knowledge about how to do things is stored in the form of standard operating procedures, routines and scripts. Policies and Procedures have been defined to represent institutional knowledge required for the efficient and consistent operation of an organisation. In exploring the tacit to explicit nature of policies and procedures, 'we must recognize that there may be a large gap between what a task looks like in a procedure and what it looks like in reality' (Brown and Duguid, 2001).

3.8 Knowledge spiral

A knowledge spiral emerges when the interaction between tacit and explicit knowledge is elevated dynamically from a lower ontological level to higher levels. It starts from individual to group to organisation-wide and to inter-organisational. It is important to note that the movement through the four modes of knowledge conversion forms a spiral, not a circle (Nonaka and Takeuchi, 1995). In the spiral of knowledge creation, the interaction between tacit and explicit knowledge is amplified through the four modes of knowledge conversion. The spiral becomes larger in scale as it moves up through the ontological levels. Knowledge created through this process can trigger a new spiral of knowledge creation, expanding horizontally and vertically across organisations. It is a dynamic process, starting at the individual level, and expanding as it moves through communities of interaction that transcend sectional, departmental, divisional and even organisational boundaries. Organisational knowledge creation is a never-ending process that upgrades itself continuously. This interactive spiral process takes place both intra- and inter-organisationally. Knowledge is transferred beyond organisational boundaries and knowledge from different organisations interacts to create new knowledge. Through dynamic interaction, knowledge created by the organisation can trigger the mobilisation of knowledge held by outside constituents such as consumers, affiliated companies, universities or distributors. For example, an innovative new manufacturing process may bring about changes in the suppliers' manufacturing process, which, in turn, triggers a new round of product and process innovation at the organisation. Another example is the articulation of tacit knowledge possessed by customers that they themselves have not been able to articulate. A product works as the trigger to elicit tacit knowledge when customers give meaning to the product by purchasing, adapting, using, or not purchasing it. Their actions are then reflected in the innovation process of the organisation, and a new spiral of organisational knowledge creation starts again.

It should be noted that knowledge creation is a self-transcending process, in which one reaches out beyond the boundaries of one's own existence (Jantsch, 1980). In knowledge creation, one transcends the boundary between self and other, inside and outside, past and present. Abe and Ives (1990) stress that, in socialisation, self-transcendence is fundamental because tacit knowledge can only be shared through direct experiences which go beyond individuals. For example, in the socialisation process, people empathise with their colleagues and customers, which diminishes barriers between individuals. In externalisation, an individual transcends the inner and outer boundaries of the self by committing to the group and becoming one with the group. Here, the sum of the individuals' intentions and ideas fuse and become integrated with the group's mental world. In combination, new knowledge generated through externalisation transcends the group in analogue or digital signals. In internalisation, individuals access the knowledge realm of the group and the entire organisation. This again requires self-transcendence, as one has to find oneself in a larger entity.

3.9 Knowledge management

KM means different things to different people (Bollinger and Smith, 2001). One central theme of KM is the assertion that the knowledge found in an organisation has to be identified and accessible. The reason for this is for such knowledge to be transferred easily for re-use by others in solving problems within and outside the organisation. Knowledge is a shared collection of principles, facts, skills and rules. More specifically, organisational knowledge aids decision-making, behaviour and actions and is primarily developed from the knowledge of individuals within the organisation. Firms strive to generate superior knowledge that, if appropriately managed, results in superior performance. Thus, knowledge is, arguably, the single most important source of core competence (Prahalad and Hamel, 1990). Knowledge may be either explicit or implicit. The former is tangible, being clearly stated and consisting of details which can be recorded and stored. Implicit or tacit knowledge is often unstated, based on individual experience and therefore difficult to record and store (Demarest, 1997). Invariably, both forms of knowledge begin as individual knowledge but, to substantially improve performance, are transformed into organisational knowledge, an often difficult feat in the case of implicit knowledge. Thus, it is the role of KM to ensure that individual learning becomes organisational learning.

There is a rapidly increasing and eclectic body of knowledge relating to KM in regard to both practitioners and academics, as shown by the following sample of definition: 'knowledge management is…knowledge creation, which is followed by knowledge interpretation, knowledge dissemination and use and knowledge retention and refinement' (De Jarnett, 1996). 'Knowledge management is the process of critically managing knowledge to meet existing needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities' (Quintas *et al.,* 1997). 'Knowledge management is the activity which is concerned with strategy and tactics to manage human-centred assets' (Brooking, 1997). These definitions and their contextual origin all relate to large private enterprise studies and include both theory and practice in a fairly seamless and often recursive manner.

The spectacular superiority of knowledge management is emblematic of the increasing attention paid by organizations to their internal capabilities. The dominant discourse within the corporate environment is one that emphasises the need for organisations to leverage their 'knowledge base' in order to gain competitive advantage. The global management consulting network has led to the packaging and commoditisation of knowledge management programmes. Such programmes are both image and rhetoric intensive. We would argue that such programmes have played an important role in establishing 'knowledge' as a master concept of contemporary organisational life (Scarborough and Swan, 2001). KM, emerging as it has done out of attempts to theorise practice, draws upon a wide variety of terms and practical techniques. There are thus many different veils of knowledge, differing according to context. Similarly, KM practices may span across a diverse range of managerial activities. For instance, this range may include systems which attempt to measure and account for intellectual capital, efforts to exploit intellectual property rights and attempts to the capture the results of project-based learning.

According to Spender and Scherer (2007), KM is about shaping the purposive and the agentic activity of those working under incomplete knowledge, while their interactions are being directed towards chosen goals, so instantiating the organisation. Analyses based on reason and on imagination complement each other, are co-dependent. The latter focuses on practice, going beyond rational decision-making as a complete explanation of practice, so bringing the analysis closer to managers' experience. The organisational actors' knowledge can be defined as their distinctive way of both constructing and living in the context created. The management process, given this framing, is a forcing, encouraging, or tempting of others to dwell in the organisational context agentically, in ways that recreate the organisation and move it towards its goals – which also means adopting the values implicit therein (Simon, 1999). So the necessary precursor to organisational practice is what Simon dub the 'decision to participate', the individual's decision to adopt and enter into the organisation's life-world. This is the recruit abandoning his or her personal agency to take up that of the firm, becoming an agent to the shareholders as principals. Sometimes people have no choice about this and are press-ganged, like those growing up in a 'company town'. Sometimes, in democratic society, they have a choice and the organisation emerges as a negotiated order. Sometimes people simply act rationally and trade their freedom for whatever the job brings.

KM has, as its crux, the rendering of knowledge to the end-user in the organisation as and when it is required. In other words, knowledge should be in such a state that, when it is sorted for, it can be accessed in order to be used and re-used. Scarborough and Swan (2001) corroborate this by stating that, KM is '… a loosely connected set of ideas, tools and practices centering on the communication and exploitation of knowledge in organisations'. The practices that take place in the managing of knowledge include capture, packaging, transfer and re-use of knowledge which is available in both tangible and intangible form in an organisation.

In as much as there are practices that make up KM, it is important to note that knowledge to Alavi and Leidner (2001), is viewed from five perspectives: state of mind, which emphasises knowing through experience and study (Schubert *et al.,* 1998); knowledge as an object, which sees knowledge as a thing that should be stored and manipulated (McQueen, 1998; Carlsson *et al.,* 1996); knowledge as a process, which centres on knowing and acting (Zack, 1999a); knowledge as condition, stressing its importance as giving access (McQueen, 1998); and knowledge as a capability, which sees knowledge as having the capability of influencing future action (Carlsson *et al.,* 1996).

These different perspectives of knowledge lead some writers (e.g. Carlsson *et al.,* 1996; Luen and Al-Hawarden, 2001) to view KM not only as constituting practices (i.e. from the practice point of view), but also positioning the knowledge that is being managed within three broad paradigms. These are knowledge as an object, knowledge as a process and knowledge as a capability. In some literature (Borghoff and Pareschi, 1998; Gold and Malhotra, 2001; Tiwana, 2001), these paradigms are referred to as IT perspective, socialisation perspective and information system (IS) perspective, respectively.

The object paradigm views knowledge as constituting access to information, thereby implying that KM is concerned with building and managing knowledge reserve (Borghoff and Pareschi, 1998). Also ensuring that, KM focuses on making explicit the knowledge that is available in the form of knowledge items, widely accessible in the organisation (Rezgui, 2007). The process paradigm holds that KM is primarily about the flow and processes (practices) that go into the creation, transfer and distribution of knowledge (Gold and Malhotra, 2001; Becerra-Fernandez and Sabherwal, 2001). The capability paradigm views the understanding and building of core competences and strategic advantages for the emergence of intellectual capital as the main aim of KM. This can be made possible by putting in place the right KM strategy (Tiwana, 2001; Schultze and Leidner, 2002).

A study by Miguel *et al.* (2006) examined knowledge management issues in knowledge-intensive SMEs, in two knowledge-intensive SMEs in the South Yorkshire region, UK, using interpretive paradigm and interview as data collection instruments. The results indicated that owner/managers of SMEs do not perceive KM as a business critical function. While both small and medium companies collect and store explicit knowledge in the form of training materials, newsletters, databases and company's website, they do not seem to make active use of them as a source of knowledge. Similarly, Thomas (2003) studied KM and occasional link with performance, in some European Manufacturing Companies (MNC), focusing on the variables of knowledge development; knowledge utilisation; and knowledge capitalisation. The results revealed that, in all cases, new knowledge was developed through various means, but it did not result in widespread utilisation and in overall improvements in profitability. Davies (2005), in a study of ‘The global and the local in knowledge management’, assessed Du Pont, a multinational company focusing on the practices, bottle-necks and constraint of KM and knowledge sharing. The findings revealed that information overload was a constant constrain, especially among the R&D personnel. The results further showed that the amount of information pushed to people through e-mails, document attachments and databases, in addition to physical means, is much higher than what can be meaningfully processed by most in the time available. Chun-Ming *et al.* (2012), in a study of ‘Factors affecting knowledge management success: the fit perspective’, in an aerospace manufacturing company in Taiwan, found that KM system capabilities and task characteristics can improve KM performance. This result provides strong support for the relationship between fit and performance. Silva *et al.* (2013) studied KM and its relation to learning organisations (LO). Retail business employees working in organisations in Lebanon were surveyed to test whether KM enhances LO or *vice versa*. The results indicated that the two dimensions of LO and KM are distinct and that KM enhances LO more than LO enhances KM.

Hammandy *et al.* (2013) studied managing knowledge for a successful competence exploration using a sample of 249 Spanish industrial companies. The results show that organisational absorptive capacity and the firm’s old knowledge positively affect exploitation of existing opportunities. In relation to the interaction between internal exploitation and firm performance, the results show a positive and significant effect. John *et al.* (2012) theorised that teams are often neglected as an important sub-process of knowledge management practices in organizations. The study discovered serious deficits in current literature on the use of teams in organisational knowledge management practices. The findings of the review show that the benefits teams can have on organisation within the knowledge management process are enormous, ranging from effective knowledge creation, knowledge retention and knowledge transfer.

3.10 Agricultural sector and agricultural research

The study of economic history provides us with ample evidence that an agricultural revolution is a fundamental pre-condition for economic development (Eicher and Witt, 1964; Oluwasanmi, 1966; Jones and Woolf, 1969). The agricultural sector has the potential to be the industrial and economic springboard from which a country's development can take off. However, agricultural activities are usually concentrated in the less-developed, rural areas, where there is a critical need for rural transformation, redistribution, poverty alleviation and socio-economic development (Stewart, 2000). In a comparative study of Nigerian and Brazilian agricultural sectors, Ogen (2007) described the two countries as similar and moving at the same rate in the 1960s and 1970s. It stated that the Nigerian economy, like that of Brazil, during the first decade after independence could reasonably be described as an agriculture-based economy, because agriculture served as the engine of growth of the overall economy (Ogen, 2003).

From the standpoint of occupational distribution and contribution to the GDP, agriculture was the leading sector. During this period Nigeria was the world's second largest producer of cocoa, largest exporter of palm kernel and largest producer and exporter of palm oil. Nigeria was also a leading exporter of other major commodities such as cotton, groundnut, rubber and hides and skins (Alkali, 1997). The agricultural sector contributed over 60% of the GDP in the 1960s and, despite the reliance of Nigerian peasant farmers on traditional tools and indigenous farming methods, these farmers produced 70% of Nigeria's exports and 95% of its food needs (Lawal, 1997). To understand the situation, from the mid-70s, Nigeria became a net importer of various agricultural products. In 1982 alone, Nigeria imported 153 000metric tons of palm oil, at a cost of 92 million US$ and 55 000metric tons of cotton, valued at 92 million US$ (Alkali, 1997). Between 1973 and 1980, a total of 7.07 million tons of wheat, 1.62 million tons of rice and 431 000 tons of maize were imported. Thus, from N47.8 million in the 60s, the cost of food imports in Nigeria rose to N88.2 million in 1970 and N1 027 million in 1988 (Alkali, 1997). Since the 1990s, and until the recent ban on rice importation, Nigeria has been spending an average of 60 million US$ on the importation of rice, annually. Indeed, in 1994, the agricultural sector performed below the projected 7.2 per cent of budgetary output (Lawal, 1997).

On contrast, in Brazil, massive industrial development has been going on alongside increased agricultural productivity. This suggests that Brazil continues to develop her agricultural sector, in spite of its current status as a Newly Industrialized Country (NIC). Brazil is one of the world's top producers of no fewer than twenty-eight different agricultural commodities. It has been the biggest producer of coffee for more than a century and leads in oranges, orange juice concentrates, alcohol, sisal, cassava and bananas. It has the planet's largest commercial cattle herd and comes second only to the United States in soybean production and to India in sugarcane output. Brazil is the world's largest exporter of soybean oil, second in the exports of whole soybean and a major exporter of poultry. Brazil offers considerable competition to the United States in soybean, tobacco, poultry and beef product exports; this is despite the fact that the United States is a major exporter of these agricultural products (Graham, Gauthier and De Barros, 1987; FAO, 2003).

Based on these comparisons, Ogen (2007) suggested some comparative lessons that could be drawn by Nigeria from the structure of Brazilian agriculture in order to boost its economy; establish agro-based industries, provide agricultural subsidies for fertilizer, farm implements and equipment, provide replanting grants to cash crop farmers, alleviate rural poverty through the provision of special welfare scheme for farmers, resuscitate and develop the critical ailing Nigerian sugar industry and its bye-products, especial ethanol.

Agricultural research in Nigeria started almost a century ago, with the establishment of research stations to promote the production and export of cocoa, oil palm and rubber (Alene *et al.,* 2007). After political independence, Nigeria inherited the agricultural research system established by the colonial powers. Agricultural research in Nigeria, as in other countries in SSA, relied heavily on donor support, and donors, especially through the 1970s and 1980s, were interested in using large-scale commercial farming as an engine of growth. From the mid-1980s, however, both donors and policy-makers began to question the commercial orientation of agricultural research. This re-examination was due to the limited effectiveness of export-oriented growth, growing concern about poverty and inequality, and increasingly tight budgets. The needs of small-scale farmers became more prominent in policy discussions and the use of agricultural research to reduce pressing rural poverty became imperative (Alwang and Siegel, 2003).

Agricultural research in Nigeria, is now principally carried out by 17 national agricultural research institutes (NARIs). Six of these deal with arable crops, four with forestry and tree crops, three with livestock, two with fisheries and one with extension, processing and storage. Each has a national mandate for specific major commodities in each agro-ecological zone. Nigeria's agriculture has benefitted greatly from the international agricultural research carried out by the International Institute of Tropical Agriculture (IITA) and many other international research centres, including ICRISAT, ILRI and WARDA. Nigeria is now the world's largest producer of cassava, yam and cowpeas (Manyong *et al.,* 2005).

In Nigeria, a major reorganisation and expansion of the national agricultural research system took place when various research stations and departments were upgraded to research institutes, with specific mandates for research on food and industrial crops, livestock, forestry, fisheries, extension and processing and storage. In an effort to strengthen the agricultural research system, the National Agricultural Research Project was launched in 1992 by the Federal Ministry of Agriculture and Natural Resources, with the assistance of the World Bank (Shaib *et al.,* 1997). Through this project, the National Agricultural Research Strategy Plan, 1996–2010, was formulated. The strategic objectives were to: (1) achieve food self-sufficiency in basic food commodities and export crops; (2) improve agricultural production efficiency through increased research emphasis on socio–economic issues, such as marketing, credit, improved processing methods and the economical use of purchased inputs; (3) improve the relevance of research to client needs by focusing on the production systems of small-scale farmers; (4) strengthen research on small ruminants in the South East and South West zones; and (5) improve the output and cost-effectiveness of research through effective collaboration of the national agricultural research institutes (NARIs) with universities and the international agricultural research centres (Alene *et al.,* 2007).

Nigeria's agricultural research faces the challenge of responding to the new demands to contribute to poverty alleviation in the face of declining national research and development budgets. In 2000, for instance, although Nigeria employed the highest total number of full-time equivalent researchers in SSA (11%), its share of spending was only 7% of the total US$1.5 billion (US$10.5 million) (Beintema and Stads, 2004).

At the continental level, for example, Nkamleu (2004) investigated the changes in agricultural productivity in 16 SSA countries over the period 1970-2001 and found that total factor productivity declined in the 1970s and 1980s and showed only slight improvement after the 1990s. Similarly, Fulginiti *et al.* (2004) analysed agricultural productivity in 41 SSA countries over the period 1960-1999 and found that the rate of productivity change was only 0.83% per year.

3.11 Knowledge workers

The main feature of the 21st century, characterised by the so-called 'New Economy' (Kelly, 1998), the 'Digital Economy' (Tapscott, 1996), the 'Knowledge Economy' (Drucker, 1969; Arthur, 1996) and the 'Post Industrial Economy' (Boyett and Boyett, 2001), is intellectual capital (IC). National economies around the world have shifted towards a knowledge base, in which wealth creation is associated with the ability to develop and manage knowledge resources (KR) (see, among others, MERITUM, 2002; SKE, 2005; EC, 2006; Boedker *et al.,* 2007; Guthrie *et al.,* 2007). Knowledge managers and knowledge workers comprise the entire spectrum of KM-related positions and may include such titles/roles as Chief Knowledge Officer (CKO), knowledge broker (Dalkir, 2005), knowledge analyst (Skyrme, 2011), knowledge systems engineer (Civilian Career Path Guide, 2002). The knowledge management skills map presented by TFPL (2000) recognised certain skill sets for knowledge workers. TFPL is a UK-based recruitment, training, and consultancy company for the knowledge, information, and data industries. Their knowledge management skills map is the result of an extensive survey of over 500 organisations. According to their research, they defined the following general categories, each consisting of a large set of skills for knowledge workers:

- Strategic and Business Skills: Includes business planning, industry knowledge, strategic thinking, leadership and organisational skills.
- Management Skills: Includes business processes, people management, process mapping, team building and measurement.
- Intellectual & Learning Skills: Includes problem-solving, mentoring, conceptual thinking, being analytical and the ability to deal with ambiguity.
- Communication and Interpersonal Skills: Includes listening, negotiation, marketing, team-working and consulting.

- Information Management Skills: Includes codification, content management, information processes, taxonomies and IT applications.
- IT skills: Includes database management, information architecture, programming, software applications and workflow (KM Skills Map, 2000).

However, the skill requirements for a knowledge manager/worker could vary drastically, depending on his specific areas of responsibility. For instance, a CKO would require very strong strategy and business skills, as well as management, learning and communication skills (KM Skills Map, 2000). The CKO would not need to be as strong in IT skills as, for example, a systems engineer in charge of developing a knowledge management system.

3.12 Summary of the literature review

Literature has been extensively reviewed on variables and broader issues of this study, such as knowledge production and generation in the agricultural sector, knowledge management strategies in agriculture, knowledge dissemination in agricultural research, knowledge management, agricultural research, the agricultural sector and the knowledge worker. Review of the related literature on knowledge production and generation in the agricultural sector suggests the availability of literature globally. In this regard, some of the literature emanated from Japan (Jing *et al.,* 2009; Zakaria and Nagata, 2010); Mexico (Galindo, 2007); Zimbabwe (Mudege, 2005); Nigeria (Nicke and Ayola, 2004); The World Bank (2010); China (Shan *et al.,* 2013). It is evident from this review that few related works are found in the context of Nigeria. However, this paucity of literature has been alleviated through the research questions 1 and 2 of the present study, namely What type of knowledge is generated by the Nigerian agricultural research institutes? and What is the extent of knowledge production by the research institutes? Literature has also been reviewed on knowledge management strategies and agricultural research. These include: Nigeria (Ajaikaiye and Olusola, 2003); the United Nations (Claudia and Marc, 2010); Italy (Emanuele *et al.,* 2004; De Marchi and Grandinetti, 2013); Spain (Mario and Fatima, 2011; Daniel and Fernando, 2006); Europe (Coyte *et al.,* 2012); India (Ajay and Hans, 2013; Bijaya and Uday, 2011); Egypt (Soliman, 2003); South Africa (Noeth, 2004; Dweba and Mearns, 2011); Kenya (Munyua and Stilwell, 2013); Sierra Leone (Tarlton, 1994); Tanzania (Lwoga, 2011); Ghana (Dowoe *et al.,* 2012; Addom, 2010); the UK (Jasimuddin, 2008); and Germany (Martina *et al.,* 2008). These results showed little related works from Nigeria which suggests a gap in the literature on knowledge management strategies and agricultural research. This gap in the literature was addressed by research question 3 of the present study, namely What knowledge management strategies are used by the research institutes to drive research and innovation? Literature on knowledge dissemination in agricultural research covers the global and continental levels. These include: the U.S.A (Amayah, 2013); Multi-National Organisations (Coakes, 2006; Connell and Voola, 2013; Storga *et al.,* 2013); Italy (Mura, *et al.,* 2013); Asia (Kang and Kim, 2013); Uzbekistan (Wall, 2006); and Guatemala (Siebers, 2003). This review suggests unavailability of related works in Nigeria and about Nigeria, which the present study seeks to address through research question 4, namely How is the knowledge generated disseminated?

Based on what transpired in the literature review and theoretical framework, the present study noted the following issues: emphasis of literature on combined or hybrid knowledge management strategies encompassing personalisation strategy (human-based) and codification strategy (ICT-based); non-focus of the theories/models on the agricultural sector/agricultural research system and their general orientation on private and business practices; and non-recognition of knowledge management policy as a critical driver of KM. Consequently, the present study proposes a KM model for agricultural research system/institutes based on their peculiarities such as actors, stakeholders and responsibilities embedded in the system. The model recognises KM policy, levels of knowledge production/generation, personalisation and codification strategies for management of knowledge and knowledge and innovation diffusion platforms critical to the agricultural research system etc. (See Figure 7.1).

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

Methodology refers to a basic set of beliefs that guide the research methods of data collection and analysis (Guba, 1990; Denzin and Lincoln, 2005). Research methodology is also concerned with the understanding a researcher has about social reality, the interpretation given to a phenomenon, and the essential apparatus put in place for designing appropriate research methods comprising of techniques employed in getting to the issues to be addressed within a body of research (Cohen *et al.*, 2007). Rebeck *et al.* (2001) sum up methodology '…as a set of procedures that can be followed for achieving an objective'. The objective in this sense is that of exploring observed phenomena and getting to the root of possible causes and effects in order to understand the phenomena very well.

Research is underpinned by various beliefs or schools of thoughts. Paradigms provide the ontological and epistemological stance of a study. Some authors such as May (1997) refer to beliefs as paradigms, while some (Creswell, 2009; Guba, 1990) refer to them as worldviews. Examples of research paradigms include positivism, post-positivism, social constructivism, advocacy and participatory and pragmatic paradigms (May, 1997; Creswell, 2003, 2009; Bailey, 2007). These paradigms explain the foundation for any chosen methodology that a researcher decides to employ in doing social research, be it qualitative, quantitative or mixed method

Various scholars have pointed out that there is a link between paradigms, methodologies and methods (Knox, 2004; Creswell and Plano, 2007; Greene and Caracelli, 2003; Teddlie and Tashakkori, 2009). Paradigms provide lenses through which to view the world, while research methodologies provide an approach to studying social science. Research methods provide strategies for doing research.

The purpose of this study was to investigate knowledge management strategies and practices in Nigerian agricultural research institutes. The study sought to address the following specific research questions: What type of knowledge is generated by the Nigerian agricultural research institutes? What is the extent of knowledge production by the research institutes? What KM strategies are used in the research institutes to derive research and innovation? How is the knowledge generated disseminated? What KM infrastructure is available to the research institutes? What factors influence KM adoption in the research institutes?

Chapter Four is organised into the following broad thematic sections: research paradigms and schools of thought, research methods, research design, population of study, sampling procedures, data collection procedures, data processing and analysis strategies, validity and reliability of data collection instruments, ethical considerations and summary.

4.2 Paradigms and schools of thought in research

The present study is underpinned by the post-positivism paradigm. However, other paradigms (such as positivism, social constructivism, advocacy and participatory and pragmatic paradigms) are discussed in order to put into context the research problem, holistically.

In doing research, a researcher approaches research with certain beliefs and assumptions on how social reality is construed and understood. Dooley *et al.* (1995) defined a paradigm as a set of assumptions from which subsequent theory is developed. Paradigms have also been referred to as a systematic set of beliefs, together with their accompanying methods (Lincoln and Guba, 1985); a basic set of beliefs and assumptions which serve as touchstones in guiding activities (Guba and Lincoln, 1989); and as frames of reference in search of meaning, while making different assumptions about the nature of social reality (Wagenaar and Babbie, 2001). These beliefs are grounded in worldviews known as paradigms or schools of thought. They provide the basis (guide) for the investigation undertaken, irrespective of the method employed.

A research paradigm is defined by Guba and Lincoln (1994:105) as the 'basic belief system or worldview that guides the investigation'. This definition is read with that of Denzin (1989:245), who stated that a paradigm is 'a set of beliefs that guide action'. Actions in this context are procedures for arriving at results which unravel phenomena. The research paradigm acts as a lens that the researcher uses to view the world; therefore it reflects the worldview of the researcher.

Creswell (1998) suggests an agenda for research paradigms. In his agenda, he stated that social reality is categorised into five paradigms: the ontology issue (this is the nature of reality that the researcher investigates); the epistemology issue (the relationship that holds between the reality being researched and the researcher); the rhetorical issue (the use of specific terms and personal literary narrative by the researcher); the axiological issue (the values that the researcher aggregates to the research process); and the methodological issue (the conceptualisation of the research process in terms of techniques to be used in investigating the reality).These paradigms cut across the deductive and inductive perspective of the way social reality is construed. They also underline the interpretation of social reality, either from the subjective or objective point of view, be it in the qualitative, quantitative or mixed methodology. Although Creswell (1998) tended to portray the paradigms more from a qualitative standpoint, the quantitative method uses the aforementioned paradigms in viewing social reality. Outputs from qualitative research can be quantified (Prasad and Prasad, 2002, cited in Munyua, 2011), thereby making the methodological pursuit of the quantitative method fall within Creswell's paradigms which are supposedly qualitatively inclined.

4.2. 1 Positivism paradigm

This school of thought holds that knowledge about anything must be observable and backed with empirical evidence. Observation of the world is the first step in doing research for the positivist (Davies *et al.,* 2002). Theory is formulated using deduction to arrive at an hypothesis, which is then, tested from an existing derived theory and forms the *modus operandi* of the positivist. Data collected is used to test the hypothesis. This school of thought is held by scientists to provide the legitimate methodology for conducting scientific enquiry. The central belief is that data is collected about the social world for generalising human behaviour through theories. Bryman (2004:11) sums up positivism as 'an epistemological position that advocates the application of the natural sciences to the study of social reality and beyond'. It deals with testing the correlations between variables (King, 1999). The tendency of positivism is to operate by the laws that govern the correlation of cause and effect, which is discernable by a scientific approach (Krauss, 2005).

Positivism argues for the existence of a true and objective reality that can be studied through applying the methods and principles of natural sciences and scientific inquiry. It maintains that 'the object of study is independent of researchers; knowledge is discovered and verified through direct observations or measurements of phenomena; facts are established by taking apart a phenomenon to examine its component parts (Krauss, 2005). According to this paradigm, the role of the researcher is to provide material for the development of laws by testing theories (Bryman, 2004). Positivists believe in five principles, which include phenomenalism (knowledge confirmed by the senses can be regarded as knowledge), deductivism (the purpose of theory is to generate hypotheses that can be tested to make laws), inductivism (the gathering of facts provides the basis for laws and knowledge) and objectivism (science should be value-free) and scientific statements (Bryman, 2004).

Positivists' paradigm underpins quantitative methods of doing research (Johnson *et al.,* 2006). Quantitative methods employ numerical descriptions of trends, attitudes and opinions of a particular population by the study of a sample of that population. Researchers then generalize claims of the said population from sample results (Creswell, 2003; Richards and McEnvoy, 2006). Based on this, a positivist paradigm is not suitable for the present study, because it is quantitative research-based. To achieve the objectives of the study, a pluralistic paradigm was more appropriate to enable the collection of both qualitative and quantitative data from the population, which consisted consisting of management staff and researchers in the five research institutes to provide answers on issues such as knowledge management strategies, knowledge adoption, type of knowledge generated and extent of knowledge production and hence the use of a post-positivist school of thought. In this study, the researcher collected both qualitative and quantitative data using a questionnaire, documentary analysis and interviews. This combined method contravenes the principle of the positivists' paradigm and it is thus unsuitability for the present study.

4.2.2Social constructivism paradigm

The social constructivist paradigm holds that the basic generation of meaning is always social, arising in and out of interaction with a human community. It is predicated on qualitative research. It is also known as the interpretive, humanistic and naturalistic paradigm. The origin of constructivism can be traced back to Berger and Luckmann (1967) and the Social Construction of Reality by Lincoln and Guba's (1985) Naturalistic Inquiry (Doucet *et al.,* 2010). More recent writers who have summarised this position are Lincoln and Guba (2000), Schwandt (2007), Neuman (2006) and Crotty (1998). This paradigm maintains that social subjects and problems cannot be studied through positivism. Constructivists believe that the world is multifaceted and that there are multiple realities which are constructed, experienced and interpreted differently by different people. People give meaning to their experiences based on their experience of interaction with others, and the community and social system in which they live. Constructivism places '…interpretative aspects of knowing the social world, and the significance of the investigator's own interpretations and understanding of the phenomenon being studied' (Snape and Spencer, 2003). Constructivists assume that reality is not a fixed entity; rather individuals construct their own reality that may change as the individual becomes more informed. The paradigm maintains that knowledge is constructed and is based not only on observable facts, but also on individual values, beliefs and understanding. Constructivist research aims to present multiple, holistic, competing and often conflicting realities of involved parties, including researchers and participants (Guba and Lincoln, 1994).

The researcher's role and effect is acknowledged and together the researcher and the participants reach new constructions which are more informed, sophisticated and real to those individuals who created them. The constructed knowledge can then be transferred to other settings and contexts to enable others to examine if the constructions fit with their experiences in their own environment and contexts (Guba and Lincoln, 1989). In a nutshell, the researchers recognize that their own backgrounds shape their interpretation. They position themselves in the research to acknowledge how their interpretation flows from their personal, cultural and historical experiences. The researcher's intent is to make sense of (or interpret) the meanings others have about the world, rather than starting with a theory (as in post-positivism).

In discussing social constructivism, Crotty (1998) identified several assumptions: 1) meanings are constructed by human beings as they engage with the world they are interpreting. Qualitative researchers tend to use open-ended questions so that the participants can share their views; 2) human beings engage with their world and make sense of it based on their historical and social perspectives and we are all born into a world of meaning bestowed upon us by our culture. Qualitative researchers thus seek to understand the context or setting of the participants through visiting this context and gathering information personally. They also interpret what they find, an interpretation shaped by the researcher's own experiences and background; 3) the basic generation of meaning is always social, arising in and out of interaction with a community. The process of qualitative research is largely inductive, with the inquirer generating meaning from the data collected in the field.

One weakness of the constructivist paradigm is the cost in terms of time and resources required for gathering data. The second weakness has to do with the difficulties involved in the analysis and interpretation of data, while the third is that some people give low credibility to studies pursuing this approach (Easterby-Smith *et al.,* 2002). The constructionist paradigm has also been criticised for not formulating explicit hypotheses, but rather being guided by research questions. Although the constructionist research is considered plausible, constructivist methods can be complex and subjective (Easterby-Smith *et al.,* 2002). As pointed out by Cooper and Schindler (2003), inductive research can be carried out through observation and interviews. Apart from the above-mentioned weaknesses that can make application of this paradigm to the present study unwise, the social constructivism is qualitative research-based. This is counter-productive to the pluralistic methods of qualitative and quantitative methods applied to the present study for the collection of data from the population of both management and researchers of the five research institutes. According to this paradigm, researchers recognise that their own backgrounds shape their interpretation and they position themselves in the research to acknowledge how their interpretation flows from their personal, cultural and historical experiences (Creswell, 2009).

4.2.3 Advocacy and participatory paradigm

This philosophical worldview focuses on the needs of groups and individuals in our society that may be marginalised or disenfranchised. This position arose during the 1980s and 1990s from individuals who felt that the post-positivist assumptions imposed structural laws and theories that did not fit marginalised individuals in our society, or issues of social justice that needed to be addressed (Creswell, 2009). This paradigm is typically seen with qualitative research, but it can be a foundation for quantitative research as well. Historically, some of the writers who advocated for this paradigm include Marx, Adorno, Marcus, Habermas and Freire, cited in Neuman (2000). Fay (1987), Heron and Reason (1997) and Kemmis and Wilkinson (1998) are recent writers who advocate for this perspective. Advocacy and participatory paradigm holds that research inquiry needs to be intertwined with politics and a political agenda. Thus the research contains an action agenda for reform that may change the lives of the participants, the institutions in which individuals work or live, and the researcher's life.

The advocacy paradigm emphasises addressing some specific issues such as empowerment, inequality, oppression, domination, suppression, and alienation. Based on the above explanation, Kemmis and Wilkinson (1998), summarises the key features of the advocacy and participatory paradigm, namely: 1) participatory action is recursive or dialectical and focused on bringing about change in practices. Thus, at the end of advocacy/participatory studies, researchers advance an action agenda for change; 2) this form of inquiry is focused on helping individuals free themselves from constraints found in the media, in language, in work procedures, and in the relationships of power in educational settings. Advocacy/participatory studies often begin with an important issue or stance about the problems in society, such as the need for empowerment; 3) it is emancipatory in that it helps unshackle people from the constraints of irrational and unjust structures that limit self-development and self-determination. The advocacy/participatory studies aim to create a political debate and discussion so that change will occur; 4) it is practical and collaborative because it is inquiry completed with others rather than on or to others. In this spirit, advocacy/participatory authors engage the participants as active collaborators in their inquiries.

The critical focus of the participatory world view is to change marginalised individuals for the better (Creswell and Plano, 2007). Critics have reasoned that the participatory paradigm approaches are not reliable (Mosse, 1994) and that they shy away from standardisation and quantification (Maxwell, 1999). Beside the weaknesses pointed out above, the paradigm is not suitable for the present study because it is more in tune with qualitative research, while the present study applied both qualitative and quantitative research methods to investigate the research problem. Furthermore, the advocacy and participatory paradigm is informed by a political agenda and is geared towards addressing some specific issues such as empowerment, inequality, oppression, domination, suppression and alienation in society. This is in contrast with objectives of the present study.

4.2.4 Pragmatic paradigm

Pragmatism was derived from the work of Pierce, James, Mead and Dewey, Cherryholmes, 1992, cited in Creswell, (2009). Recent writers include Rorty (1990), Murphy (1990), Patton (2002) and Cherryholmes (1992). Pragmatism as a worldview arises out of actions, situations and consequences, rather than antecedent conditions (as in post-positivism). Instead of focusing on methods, researchers emphasise the research problem and use all approaches available to understand the problem (Rossman and Wilson, 1985). As a philosophical underpinning for mixed methods studies, Tashakkori and Teddlie (1998), Morgan (2007), and Patton (2002) convey its importance for focusing attention on the research problem in social science research and then using pluralistic approaches to derive knowledge about the problem. According to Creswell (2009), Cherryholmes (1992) and Morgan (2007), pragmatism provides a philosophical basis for research in the following ways: 1) pragmatism is not committed to any one system of philosophy or reality. This applies to mixed methods research, in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research; (2) individual researchers have a freedom of choice. Researchers are free to choose the methods, techniques and procedures of research that best meet their needs and purposes; (3) pragmatists do not see the world as an absolute unity. Mixed methods researchers look to many approaches for collecting and analyzing data rather than subscribing to only one way (e.g. quantitative or qualitative); (4) truth is what works at the time. It is not based in a duality between reality independent of the mind or within the mind. Thus mixed methods research investigators use both qualitative and quantitative data because they work to provide the best understanding of a research problem; (5) pragmatists agree that research always occurs in social, historical, political and other contexts. Mixed methods studies may include a postmodern turn, a theoretical outlook that is reflective of social justice and political aims; (6) pragmatists have believed in an external world independent of the mind as well as that lodged in the mind. But they believe that we need to stop asking questions about reality and the laws of nature (Cherryholmes, 1992). 'They would simply like to change the subject' (Rotty, 1993).

Ironically, some of the downfalls (in the context of the present study) of the pragmatic paradigm are that it is problem-centred and emanates from consequences of action. This has made the pragmatic paradigm unsuitable for the present study, because it relegates the role of methodology in scientific inquiry and focused-on problem. Despite the fact that the pragmatic paradigm is pluralistic, its principles require the participation of the researcher in the process of solving the problems being investigated by the researcher.

4.2.5 Post-positivism paradigm

Post-positivism is sometimes called the scientific method of doing science research which comes from 19th Century writers such as Comte, Mill, Durkheim, Newton and Locke, cited in Smith, (1983). Post-positivism is considered a contemporary paradigm that developed as a result of the criticism of positivism. Like positivists, post-positivists believe in the existence of a single reality. However, they acknowledge that reality can never be fully known and efforts to understand reality are limited owing to the human beings' sensory and intellectual limitations (Guba, 1990). The aim of post-positivist research is also prediction and explanation. Like positivists, post-positivists strive to be objective, neutral and ensure that the findings fit with the existing knowledge base. However, unlike positivists, they acknowledge and spell out any predispositions that might affect the objectivity (Doucet *et al.,* 2010).

Post-positivists hold a deterministic philosophy in which causes probably determine effects or outcomes. The problems studied by post-positivists reflect the need to identify and assess the causes that influence outcomes, such as is found in experiments. It is also reductionistic, in that the intent is to reduce the ideas to small, discrete sets of ideas to test, such as the variables that comprise hypotheses and research questions. The knowledge that develops through a post-positivists approach is based on careful observation and measurement of the objective reality that exists 'out there' in the world (Creswell, 2009). Thus, developing numerical measures of observations and studying the behaviour of individuals becomes paramount for the post-positivist. This, by implication, means combining both qualitative and quantitative methods in doing research to collect data through interview and questionnaire.

The key assumptions of the post-positivist approach, as encapsulated in, Phillips and Burbules (2000), includes: 1) knowledge is conjectural (and antifoundational) and absolute truth can never be found. Thus evidence established in research is always imperfect and fallible. It is for this reason that researchers state that they do not prove a hypothesis; instead, they indicate a failure to reject the hypothesis; 2) research is the process of making claims and then refining or abandoning some of them for other claims more strongly warranted. Most quantitative research, for example, starts with the test of a theory; 3) data, evidence and rational consideration shape knowledge. In practice, the researcher collects information on instruments based on measures completed by the participants or by observations recorded by the researcher, 4) research seeks to develop relevant, true statements, ones that can serve to explain the situation of concern or that which describes the causal relationships of interest. In quantitative studies, researchers advance the relationship among variables and pose this in terms of questions or hypotheses; 5) being objective is an essential aspect of competent inquiry; researchers must examine methods and conclusions for bias. For example, standard of validity and reliability are important in quantitative research. Post-positivist paradigm emphasises scientific methods in investigating research problems and understanding a phenomenon through explicitly stating a research questions, theory identification, formulating hypotheses, data collection, presentation and analysis. This is absolutely congruent with the present study. It allows the researcher to combine methods (qualitative and quantitative).

Based on the above, the post-positivism paradigm was more suitable for the present study, where the researcher used both qualitative and quantitative methods to collect empirical data from researchers, heads of documentation units and directors of the five research institutes, on the type of knowledge generated, KM strategies available, knowledge dissemination mechanisms, KM infrastructure and factors influencing KM adoption in the institutes to investigate the research problem. Advocates of alternative philosophical views have suggested the use of pluralistic philosophies and methodologies and pointed out that research studies can use aspects of more than one paradigm to be consistent and coherent with the research question and to address the complexities of social science research (Dick, 1993; Wilson, 1981; 1999; Dervin and Nilan, 1986; Gephart, 1999; Easterby-Smith, Thorpe and Lowe, 2002; Greene and Caracelli, 2003). Post-positivism is a departure from epistemological principles (theory) of positivist to ontological principles (reality) of knowledge. The post-positivist paradigm, in combination with positivist paradigm, has been used in related studies such as that of Ekeke (2011), in a PhD study entitled 'Knowledge management practices in the public sector of Nigeria: a case study of Bayelsa state'.

4.3 Methodological approach

The main methodologies or research approaches in social research include the quantitative, the qualitative (Bell, 1998; Myers, 1997; Babbie and Mouton, 2001; Creswell, 2003; Sheppard, 2004; Durrheim and Painter, 2006) and mixed methods research (Greene *et al*. 1989; Creswell, 2003; Creswell and Plano, 2007; Greene, 2008; Teddlie and Tashakkori, 2009). In the present study, the methodology consists of qualitative and quantitative methods of data collection known as mixed methods. A mixed methods research design is a procedure for collecting, analysing and 'mixing' qualitative and quantitative research and methods in a single study to understand a research problem (Creswell and Plano, 2007: 6). The basic assumption was that the use of qualitative and quantitative methods, in combination, provides a better understanding of the research problem and questions than either method by itself. Mixed methods allowed the researcher to collect qualitative data through interviews with directors and heads of documentation units and documentary analysis, while quantitative data was collected using questionnaires administered to researchers in the five research institutes. A mixed method is a 'legitimate inquiry approach' (Brewer and Hunter, 1989).

Specifically, the present study employed the use of interviews, document analysis and questionnaires as data collection instruments. This is because when one combines quantitative and qualitative data, 'we have a very powerful mix' (Miles and Huberman, 1994). For example, by assessing outcomes of a study (quantitative) as well as the process (qualitative), we can develop 'a complex' picture of social phenomena (Greene and Caracelli, 2003). It can also be conducted (mixed methods) when one type of research (quantitative or qualitative) is not enough to address the research problem or answer the research questions. More data is needed to extend, elaborate on, or explain the first database. Creswell (2009) stated that both quantitative and qualitative methods can be used developmentally because the first helps inform the second, while the second can provide additional information to support the first. Both methods were used in the present study to enhance the validity of the study findings and to increase the reliability of information gathered from the respondents regarding the type of knowledge generated, extent of knowledge production, KM strategies, KM infrastructure, knowledge dissemination, and factors influencing KM adoption in the five agricultural research institutes.

A triangulation design was used to simultaneously collect quantitative and qualitative data, merge the data and use the results to understand the research problem. A basic rationale for this design is that one data collection form supplies strength to offset the weaknesses of the other form (Creswell, 2008). According to Jick (1979), there is a tradition of literature in the social sciences that advocated for the triangulation of methodologies. The logical mix of multiple methods was considered useful, regardless of whether there was convergence or not in the mixing of methodologies. Jick (1979) reasoned that while convergence could help to increase confidence in results, inconsistencies could equally help to explain a research problem. Supporting the combination of methodologies, Firestone (1987) asserts that a mix of qualitative and quantitative methodologies presented the researcher with different information that could be used to gain greater confidence in the researcher's conclusions. For example, the quantitative score on an instrument from many individuals provides strengths to offset the weaknesses of qualitative documents from a few people. In the triangulation design, the researcher gathers the quantitative and qualitative data, analyses both datasets separately, compares the results from the analysis of both datasets and makes an interpretation as to whether the results support or contradict each other. Triangulated design, as used by Dweba and Mearns (2011), Tarlton (1994), Munyua and Stilwell (2013), Aybuke *et al.* (2008) and Ndoro (2011), in similar studies to simultaneously collect quantitative and qualitative data, merge the data and use the results to understand the research problem.

A review by Greene, Caracelli and Graham (1989) suggests five reasons for mixing methodologies, namely: i) triangulation of methods, which leads to multiple dimensions, convergence or corroboration that enhance credibility; ii) complementarity which leads to elaboration or clarification, leading to a better understanding of the research problem; iii) development of synergistic effects that help to inform other methods; iv) initiation of new areas that lead to discovery, contradictions, or further research; and v) expansion of knowledge by using different methods. Emphasising the importance of mixed methods methodology, Rocco *et al.* (2003) concluded that triangulation of methodologies provide an approach for providing insight into relationships among methods used.

4.4 Research design

Babbie and Mouton (2001) defined research design as a plan or blueprint for how a researcher intends to conduct the research. Research design is the overall plan for obtaining answers to the questions being studied and for handling some of the difficulties encountered during the research process (Polit and Beck, 2004). In a similar vein, Yin (1989) defined a research design as a logical sequence that connects the empirical data to a study's initial research question and, ultimately, to its conclusions or to an action plan for moving from the research questions to data collection, analysis, interpretation and solutions to the problems. Sekaran (2003) and Kothari (2004) corroborated Yin's (1989) viewpoint and added that a research design offers several critical decision-making options on how data can be efficiently collected and analysed to reach a solution.

Survey design is consistent with post-positivism paradigm, which is pluralistic and allows the application of mixed methods because the survey researcher collects quantitative, numbered data using questionnaires (mailed questionnaire) and qualitative data using interviews (one-on-one interviews) and statistically analyses the data to describe trends about responses to questions and to test research questions or hypotheses (Creswell, 2008). It is useful to use when researchers seek to collect data quickly and economically, study attitudes and opinions and survey geographically dispersed individuals. This is consistent with the present study, because the institutions upon which the present study is based are dispersed in different geo-political zones of Nigeria, namely north-west, north-central, north-east, south-west and south-east.

Survey design permits the researcher to summarise the characteristics of different groups and to measure their attitudes and opinions towards knowledge management (Donald *et al.,* 2006). The reason for using survey design was to allow for the collection of empirical data from the sample drawn in the five research institutes, using questionnaires, interviews and document analysis, and to analyse the data statistically to describe the state of knowledge management practices in the institutes. Survey studies describe trends in the data rather than offering rigorous explanations (Creswell, 2008). Survey design has been used in similar studies by Dawoe *et al.* (2012), Munyua and Stilwell (2013), Lwoga (2011) and Yuanmei *et al.* (2011).

4.5 Population of the study

According to Donald *et al.* (2006), a population in research is defined as all members of any well-defined class of people, events, or objects. In other words, a population is any group of individuals who have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type or a more restricted part of that group (John and James, 2007). The target population of this study consisted of all the 17 agricultural research institutes in Nigeria which include the following;

1. Arable Crops Research Institute
2. National Agricultural Extension Research and Liaison Services (NAERLS)
3. Institute for Agricultural Research (IAR)
4. Institute of Agricultural Research and Training (IAR&T)
5. National Cereals Research Institute (NCRI)
6. Lake Chad Research Institute (LCRI)
7. National Root Crops Research Institute (NRCRI)
8. Forestry, Horticulture and Tree Crops Research Institute
9. Forestry Research institute of Nigeria
10. National Horticulture Research Institute (NIHORT)
11. Cocoa Research Institute of Nigeria (CRIN)
12. Nigerian Institute for Oil Palm Research (NIFOR)
13. Rubber Research Institute of Nigeria (RRIN)
14. Animal Production, Fisheries and Oceanography Research Institute
15. National Animal Production Research Institute (NAPRI)
16. Animal Health Research Institute
17. National Veterinary Research Institute (NVRI) – VOM .

Out of the 17, five research institutes were purposively chosen from the five geo-political zones. Each zone has one major agro-based research institute (A.R.C.N., 2008). The five institutes covered serve as zonal agricultural research co-ordinating institutes for all the states within the zones. The research institutes include (A.R.C.N., 2008):

1. National Root Crops Research Institute (NRCRI), Umudike, Abia State (South-East), covering Abia, Akwa Ibom, Anambra, Bayelsa, Cross-Rivers, Ebonyi, Enugu, Imo and Rivers States.
2. Institute for Agricultural Research and Training (IAR&T), Ibadan, Oyo State (South-West) covering Ogun, Oyo, Osun, Ondo, Ekiti, Edo and Delta States.
3. National Cereals Research Institute, Badeggi, Niger State (North-Central), covering Niger, Abuja FCT, Kwara, Kogi and Benue States.
4. Institute for Agricultural Research (IAR), Zaria, Kaduna State (North-West), covering Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara States.
5. Lake Chad Research Institute (LCRI), Maiduguri, Borno State (North-East), covering Gombe, Bauchi, Adamawa, Taraba, Yobe and Borno States.

4.6 Sample size and sampling procedure

A sample is a subgroup of the target population that the researcher plans to study for gaining general information about the target population (Creswell, 2008). The purpose of drawing a sample from a population is to obtain information concerning that population. It is extremely important that the individuals included in a sample constitute a representative cross-section of individuals in the population. Sampling is important in qualitative research, just as it is in quantitative research. Qualitative researchers cannot observe everything about a group, organisation or site that might be relevant to the research problem, but they try to obtain a sample of observations believed to be representative of everything they could observe (Donald *et al.,* 2006).

The population of this study is 1 363. According to Israel (2012), if the population is 1 363 at ±5% precision, the sample should be 286 at the 95% confidence level.

The sample of each institute was calculated proportionately, using a formula recommended by Krejcie and Morgan (1970,) as represented below:

$$\frac{N \text{ x } S}{TP}$$

Where,

N = Number (i.e. population of each institute)

S = Sample T (total sample size)

P = Population

Based on this formula, the distribution of samples across the five research institutes was;

1. I.A.R Zaria $\frac{274}{1,363} \times 286 = 58$

2. I.A.R. & T Ibadan $\frac{292}{1,363} \times 286 = 61$

3. L.C.R. I Maiduguri $\frac{267}{1,363} \times 286 = 56$

4. N.C.R.I Badeggi $\frac{262}{1,363} \times 286 = 55$

5. N.R.C.R.I Umudike $\frac{268}{1,363} \times 286 = 56$

Table 4.1: Relative populations and corresponding sample sizes of the institutions

S/No.	Research Institutes	Staff Population	Sample Size
1.	I.A.R. Zaria, Kaduna State (North-West)	274	58
2.	I.A.R.&T. Ibadan, Oyo State (South-West)	292	61
3.	L.C.R.I. Maiduguri, Borno State (North-East)	267	56
4.	N.R.C.R.I. Umudike, Abia State (South-East)	268	56
5.	N.C.R.I. Badeggi, Niger State (North-Central)	262	55
	Grand Total	**1,363**	**286**

(**Source**: Web Sites of the respective institutes and personal contacts, February 2014)

A purposive sampling technique was used to choose one director and a head of documentation from each of the five institutes to be interviewed. A purposive sample, also commonly called a judgmental sample is one that is selected based on the knowledge of a population and the purpose of the study (Robson, 2002). Purposive sampling is popular in qualitative research. The simple random sampling technique was used to administer the questionnaire to the researchers face-to-face from the comfort of their offices in the research institutes. Simple random sampling is a basic method assumed in statistical methods and computations. According to May (2001), the main benefit of the simple random sample is that each member of the population has an equal chance of being chosen. This means that it guarantees that the sample chosen is representative of the population.

4.7 Method of data collection

The process of data collection is concerned with the actions that a researcher takes to gather relevant data in order to be able to proffer answers to research questions. As mentioned earlier, mixed methods were employed in the study. This meant the application of both qualitative and quantitative data collection methods and instruments. The study used interviews and documentary sources to collect qualitative data from directors of the institutes/heads of documentation units. The questionnaire was used to collect quantitative data from the researchers belonging to the institutes.

4.7.1 Qualitative method

Various authors (Babbie and Mouton, 2001; Sapsford and Jupp, 2006; Teddlie and Tashakkori, 2009) have described qualitative methods as methods used where in-depth analysis is required, involving the collection of textual or verbal data, or graphic data. The data collected places emphasis on words, as opposed to quantification in data collection and analysis or statistical summaries, and may be in the form of people‘s words or descriptions of the researcher, based on observation and experience (Babbie and Mouton, 2001; Bryman, 2004; Denzin and Lincoln, 2005; Durrheim and Painters, 2006; Sapsford and Jupp, 2006). Thus, qualitative research emphasises the socially constructed nature of reality (Denzin and Lincoln, 1994), a holistic description of phenomena and is process oriented (Heck, 2004). It uses complex descriptions to describe phenomena (Beins, 2004; Leedy and Ormrod, 2005). Creswell (1998:15), in defining this form of research notes that:

> Qualitative research is multi method in focus, involving an interpretative, naturalistic approach to its subject matter… [It] is an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyses words, reports detailed views of informants, and conducts the study in a natural setting.

Instruments of data collection under the qualitative methods are focus group interviews, documents, and observation. The data collection tools that were adopted for the qualitative part of the study included semi structured interviews and document analysis (See Appendix 14, 15 and 16 respectively).

4.7.1.1 Semi-structured interview

This instrument was used in order to have an understanding of the processes and activities that exist in the Nigerian agricultural research institutes and to determine if traces of KM can be deduced from them. Questions regarding knowledge generation, KM infrastructure, KM strategies and knowledge dissemination were asked, using interviews. The result of this interview was used side-by-side with that of other instruments to reaffirm or to detect convergence or divergence. The questions in the interview started from generic to specific (See Appendix 14 and 15 respectively), logically flowing into each other, but allowing room for respondents to run on with their response (fluid question). Although the questions were in a standardised (written) format, the researcher was at any point seeking for clarification and elaboration (if required) on the answers given (May, 1997).

The interviews served as a good way of having an in-depth understanding of the observed phenomenon first hand. They give an understanding of examples, 'what is said and why it is said'. Another advantage of using interviews is that they give a prepared explanation of the purpose of the study more convincingly. The semi-structured interviews scheduled produced a standardised explanation to the problems that were investigated, prevented misunderstandings and, at the same time, maintained control over the sequence in which the questions were answered. Generally, the interview questions for the group that included directors (CEOs) and the heads of information and documentation units of the five research institutes covered themes such as; KM policy; type of knowledge generated and managed; correlation between KM and institutes' success; generation of explicit knowledge versus tacit knowledge; extent of knowledge production; knowledge sharing and dissemination; responsibilities and position of the knowledge manager; KM strategies and initiatives; knowledge audit; KM best practices; KM infrastructure, facilities and repositories; staff training and development for KM; KM for national agricultural development; and ICTs application for KM.

4.7.1.2 Documents analysis

Qualitative researchers may also use written documents to gain an understanding of the phenomenon under study (Donald *et al.,* 2006). The term 'documents' here refers to a wide range of written, physical and visual materials, including what other authors may term artifacts. In the present study, the researcher consulted written sources (official) in order to gain access to documents such as files, reports and memoranda, in order to uncover issues regarding policies on KM, KM strategic plan, KM systems and others that were directly related to the problems under investigation. The documents were coded into themes as follows: Policy documents on KM; KM strategic plan of the institutes; instances of KM application e.g. new product developed by the institutes; and explicit knowledge repositories such as maps, manuals and blueprints.

4.7.2 Quantitative method

Quantitative research methodology has been described as a research strategy that emphasises numbers in the collection of data and statistical analysis (Bryman, 2004; Durrheim and Painter, 2006; Sapsford and Jupp, 2006). The objective of quantitative research is to provide facts that can be applied to predict, explain causality and validate existing relationships among variables through translation of numerical data (Hair *et al.,* 2003; Leedy and Ormrod, 2005). The quantitative method of research uses standardised measures and statistical techniques in measuring data that is collected. The thinking within quantitative research is that of cause and effect, reduction to variables that are specific, hypothesis and the test of theories using predetermined instruments that results in statistical data (Creswell, 2003). It measures variables with some precision, using numerical scales (nominal, interval and ordinal). Proponents of quantitative methods emphasise reality, objectivity and causal explanation (Greene *et al.,* 2005). Data from quantitative methods is considered systematic and standardised and findings are hence considered to be objectively measured to justify the broad and generalisable comparisons

(Patton, 2002; Durrheim and Painter, 2006). Analysis of quantitative data is a way of comparison, which, according to Sapsford and Jupp (2006), is a central logical device that establishes the validity of a line of argument, showing how findings diverge from expectations. Some of the instruments of data collection in this method include a survey questionnaire. For the purpose of the present study a questionnaire (See Appendix 13), was used to collect quantitative data from the population of researchers in the five research institutes.

4.7.2.1 Questionnaire

There are three types of questionnaire, face-to-face, mail or self-completion and the telephone survey (May, 1997). Of three mentioned, the most cost-effective, is the mail or self-completion questionnaire, because the effort required to distribute it is not so hectic time consuming and cumbersome. For the present study, the face-to-face questionnaire was used because the researcher had to travel and spend a certain number of days at a particular research institute.

The strength of a quantitative method (questionnaire technique) lies in its method of administration. In this study all efforts were made to effectively administer the questionnaire to the respondents and retrieve it reliably. This was done through personal contact with the respondents (researchers). The questionnaire was organised in sections A-H, covering questions 1-47. The issues covered the following themes:

- KM practice
- Areas of research priorities
- Knowledge officers and their roles
- Type of knowledge generated
- Knowledge sharing among researchers
- Explicit knowledge generation versus tacit knowledge generation
- KM activities performed
- Knowledge creation/production processes
- KM resources and techniques
- Skills and expertise for KM
- Capacity building for KM
- Experts and specialists for Knowledge Management Systems

- Documents Management Systems and Knowledge Management Systems
- Challenges of KM

4.8 Data processing and analysis

Data analysis is a process by which researchers systematically search and arrange their data in order to increase their understanding of the data and to enable them to present what they have learnt to others (Donald *et al.,* 2006). Data analysis involved employing methods such as codes, coding systems and networks, in sorting, arranging and presenting data. Dey (1993:30), explains that 'analysis involves the process of breaking data into smaller units to reveal their characteristic elements and structure'. The structures are used in explaining the phenomenon being studied. The methods used to analyse the data collected through the three instruments (questionnaires, interviews, and documentary analysis) are explained in the following sections.

4.8.1 Questionnaire data

The data collected from the survey (questionnaire) was sorted, scrutinised, edited and analysed using the Statistical Package for Social Sciences (SPSS) version 20.0 for Windows 7, to generate descriptive statistics and inferential statistics. Descriptive statistics were used to obtain percentages and frequency. Scatter plots, pie and bar charts were used to complement the descriptive statistics and results that were obtained. The frequency and percentage displayed a number of occurrences side-by-side with the corresponding percentage, as well as relating this to the variables used in the research. Cross tabulation was carried out to generate a Chi-Square test regarding the differences and relationships that exist between the five institutes in knowledge management activities.

4.8.2 Interviews and documentary analysis data

Analysis of qualitative data in this study involved reading through the interview transcripts and documentary data, developing codes, coding the data and developing themes. Three steps of qualitative data analysis, as encapsulated in Miles and Huberman (1994:11), were employed. These are data reduction, data display and conclusion drawing/verification.

4.9 Validity and reliability of the research instruments

Validity and reliability are two critical elements that determine the worthiness and acceptability of research findings. Validity concerns the closeness of what we believe we are measuring to what we intended to measure, while reliability concerns how far a particular test, procedure or tool, such as a questionnaire, will produce similar results in different circumstances, assuming nothing had changed. Welman *et al.* (2010) described validity as the extent to which the research findings accurately represent what is really happening in the situation. An effect or test is valid if it demonstrates or measures what the researcher thinks or claims it does. Reliability means that the information provided by indicators (for example a questionnaire) does not vary as a result of characteristics of the indicator, instrument, or measurement device itself (Neuman, 1994). Welman *et al.* (2010) feel that reliability is concerned with the findings of the research and relates to the credibility of the findings. Reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed (Leedy and Ormrod, 2001). To ensure reliability of the instruments, Cronbach's alpha coefficient and 'Split-half-test' was used. This involves splitting the test in two and the score of each half of the test is compared with the other. If the test is consistent it leads the experimenter to believe that it is most likely measuring the same thing (Babbie and Mouton, 2001; Pickard, 2007).

The present study used various methods to ensure that the validity and reliability of the findings were achieved. These were by pre-testing data collection instruments and the combination of data gathering methods, such as the questionnaire, interview schedule and document analysis checklist, using National Agricultural Extension and Research Liaison Services (NAERLS) Zaria (on 5-6 July, 2014), which is not one of the five institutes selected for this study. The development of the interviews and questionnaire instruments was based on the review of the literature. Themes were derived from previous studies related to knowledge management practices in the Nigerian public service, knowledge creation and flow in agriculture in Japan, information management and agricultural extension services such as those conducted by Ekeke (2011), Zakaria and Nagata (2010), Jones *et al.* (1987), Kaniki (1989), Roling (1990), Majid *et al.* (2000), Middendorf (2007) and Fukuda (2008). Adapting research instruments is a legitimate way of attaining validity and reliability of the instruments (Creswell, 2009).

4.9.1 Pre-testing of research instruments

It is important for a researcher to test his/her survey instrument(s) before using it to collect data. Pre-testing and piloting helps to identify questions that do not make sense to participants, or problems with the instruments that might lead to biased answers. A response could be the following: 'I don't understand this question, I can't find the next section. This is getting boring, why is it too long, the option I want is not available'. Krishnaswami and Ranganatham (2010) state that the purpose of pre-testing is to test whether or not the instruments would obtain the responses required to achieve the research objectives, to test whether or not the content of the instruments is relevant and adequate, to test whether or not the wording of questions is clear and suited to the understanding of the respondents, to test the other qualitative aspects of the instrument such as question structure and to develop appropriate procedures for administering the instrument with reference to field conditions. The present researcher pre-tested the research instruments at the National Agricultural Extension and Research Liaison Services (NAERLS) Zaria, for the purpose of ensuring their reliability and validity, as well as to determine if the questions in the instruments met the research questions set for the study. The purpose of pre-testing was to identify parts of the instruments that were difficult for pre-test subjects to read or understand, or that could have been misinterpreted by them. In this institute, an Assistant Director (Research and Planning) was interviewed and 30 copies of the questionnaire were distributed to researchers. The respondents were requested to give their views on the data collection instruments. Their responses (suggestions) were used to further improve the instruments. The issues raised by the respondents include the arrangement and sequence of questions on the survey instrument and difficulties in comprehending some terminologies. The researcher responded by swapping some of the questions and interpreting the terminologies (placed the meaning in parenthesis against each term) for easy understanding, as shown in Appendix I3, questions 15 and 29. The surest way of protection against error and ambiguity in research instruments is to pre-test in full or in part (Babbie and Mouton 2001).

The reliability in this study was further achieved by conducting test-retest reliability and subjecting the results obtained to a Cronbach's Alpha, to determine the measure of internal consistency and reliability of the instruments. Based on the test-retest, the expected reliability stood at $r = 0.786$, which was high enough for the reliability of the instruments to be accepted (see Table 4.3). The correlation coefficient of 0.70 and above suggests that the questionnaire is highly reliable and can be recommended for use and the variance in the scores is reliable variance (Marsh and Hocevar, 1988; Lance *et al.,* 2006). Polit and Beck (2004) point out that the most widely used method for evaluating internal consistency is coefficient alpha (or Cronbach's alpha), whose normal range of values is between 0.00 and +1.00. Higher values reflect a higher internal consistency. A value of 0.70 is sufficient for early stages of research, but this basic research should require test scores to have a reliability coefficient of 0.80 or higher (Nunnally and Bernstein, 1994). The procedure suggested that the questionnaire had a strong content validity. The formula for calculating Cronbach's Alpha reliability is indicated below, while Tables 4.2 and 4.3 show the summary of the test.

$$a = \frac{Kr}{(1 + (k-1)\, r)}$$

Table 4.2 Reliability processing summary (N=30)

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Table 4.3 Reliability statistics (N=30)

Reliability Statistics

Cronbach's Alpha	N of Items
0.786	110

4.10 Ethical considerations

Ethical issues are crucial in any research, because researchers need to protect their research participants; develop trust with them; promote the integrity of research; guard against misconduct and impropriety that might reflect on their organisations or institutions; and cope with new, challenging problems (Israel and Hay, 2006). In research, two concepts are very important to note, namely anonymity and confidentiality. While the former has to do with a researcher not identifying a respondent in a study, the latter means a researcher can match names with responses but must ensure that no one else will have access to them (De Vaus, 2002). In this regard, the researcher in the present study explained the nature of the research to the respondents in order to clarify and reassure them of their total confidentiality and develop their trust. Their identity and the data collected will be handled with the strictest care and use for no other purpose than academic. During the interview, the researcher ensured that respondents' consent was sought before the recording take place. In addition, the researcher complied with the ethical protocol of the University of KwaZulu-Natal (See Appendix 17).

The researcher also secured permission (gatekeeper letter) from the five research institutes to carry out the research. The institues are: Institute for Agricultural Research (IAR), Zaria, Institute for Agricultural Research and Training (IAR&T) Ibadan, National Cereals Research Institute (NCRI) Badeggi, National Root Crops Research Institutes (NRCRI) Umudike and Lake Chad Research Institute (LCRI) Maiduguri for the issuance of the gatekeeper clearance. A consent form was signed by all respondents in the study areas before commencement of the study. According to Greener (2011), informed consent should provide detailed information about the research, so that prospective participants can make an informed decision on their possible involvement. Greener further emphasised that this consent should be sought in written form and signed by the research subjects. All respondents were assured of confidentiality and of their right to withdraw at any point of the study, for any reason, without consequences.

4.11 Summary

Chapter Four presented the methodology employed in the present study. The chapter discussed the research paradigms commonly used in social research and rests on the post-positivist paradigm, which is consistent with the survey design employed for the study. The study combined qualitative and quantitative approaches, known as mixed methods, of doing research. The study population, sample size and sampling procedure, data collection instruments, data processing and analysis, validity and reliability of the research instruments, as well as ethical considerations, were presented and discussed in order to provide grounding and direction for the study.

CHAPTER FIVE

DATA PRESENTATION AND ANALYSIS

5.1 Introduction

This chapter presents the findings of the study derived from the three instruments used for the collection of data, namely: questionnaire, semi-structured interviews and documentary analysis. The findings of the study are organised and presented according to the main and specific research questions as encapsulated in Chapter One section 1.4. The data analysis and interpretation are presented as a series of steps, with one step leading to the next for a complete discussion of the data analysis process (Creswell, 2008). The main research question was to investigate knowledge management strategies and practices in Nigerian agricultural research institutes, while the actual research questions are as follows:

- What type of knowledge is generated by the Nigerian agricultural research institutes?
- What is the extent of knowledge production by the research institutes?
- What knowledge management strategies are used by the research institutes to drive research and innovation?
- How is the knowledge generated disseminated?
- What knowledge management infrastructure is available to the research institutes?
- What factors influence knowledge management adoption in the research institutes?

In this study, 276 researchers were invited to participate in the survey. Two hundred and fourteen completed and returned the questionnaire, giving a response rate of 77.6%. Ten principal officers (five directors of the institutes and five heads of information and documentations units) were targeted for interview, from which four directors and four heads of information and documentations were reached, giving a response rate of 80%. The two response rates of 77.6% (questionnaire) and 80% (interviews) are considered sufficient and representative (Nathan, 1999). Babbie and Mouton (2001) state that the overall rate of response is a guide to the representativeness of the sample of respondents. If a high response rate is achieved, there is less chance of significant response bias than in a low rate response. They stipulated that a response rate of 50 per cent is adequate for analysis and reporting. A response of 60 per cent is good and a response rate of 70 percent is very good. Therefore, based on Babbie and Mouton's criteria (2001), the response rates obtained in this study were deemed adequate.

This chapter is divided into three main sections. The first section contains the presentation and analysis of findings from the questionnaire. This is followed by the second section, which is the presentation and analysis of data from the semi-structured interviews, while section three is devoted to the presentation and analysis of results from the documentary analysis. The analysis of quantitative data is separated from the qualitative data, following Creswell's proposition that a researcher can analyse quantitative data separately from qualitative data, especially in explanatory and exploratory designs (Creswell, 2008).

5.2 Analysis of data from questionnaire using descriptive statistics

The main data derived from the survey questionnaire are analysed in this section.

5.2.1 Study respondents (N=276)

This section presents the total number of returns *vis-à-vis* the total number of questionnaires administered to the population of researchers in the five research institutes, as depicted in Table 5.1.

Table 5.1 Response rate from the five research institutes (N=214)

Institutes	**Expected Respondents (N=276)**	**Actual Respondents (N=214)**	**% of Actual Respondents**
I.A.R. Zaria	56	47	83.10
I.A.R.&T. Ibadan	59	42	71.18
N.R.C.R.I. Umudike	54	44	81.48
N.C.R.I. Badeggi	53	41	77.35
L.C.R.I. Maiduguri	54	40	74.07
Total	**276**	**214**	**77.6**

The results in Table 5.1 show that 214(77.6%) questionnaires were completed and returned out of the total 276 that were administered. In this regard, 47(83.10%) were returned from I.A.R Zaria, 42(71.18%) from I.A.R. &T. Ibadan, 44(81.48%) from N.R.C.R.I. Umudike, 41 (77.35%) from N.C.R.I. Badeggi, 40(74.07%) from L.C.R.I. Maiduguri. From these results, it is evident the highest returns were recorded at I.A.R. Zaria, with 83.10%, followed by N.R.C.R.I. Umudike, with 81.48%.

5.2.2 Results of demographic data analysis (N=214)

This section provides a summary of the demographic distribution of the respondents who participated in the survey. The demographic information sought from the researchers included the department of the respondents, the number of years in the department, other departments worked in during the last five years, position/rank of respondents, age, gender and educational status/qualification of the respondents.

5.2.2.1 Department/unit/programme of respondents (N=214)

The respondents were asked to indicate the department/unit/programme in which they are working. Table 5.2 shows the department/unit of the respondents

Table 5.2 Department/unit/programme of the respondents (N=214)

Department/Unit/Programme of Respondents				
Department/Unit/Programme	**Freq**	**%**	**Valid %**	**Cumulative %**
Agric Econs & Ext Programme	18	8.4	8.4	8.4
Farming System	29	13.6	13.6	22.0
Biotechnology	26	12.1	12.1	34.1
Product Development Programme	38	17.8	17.8	51.9
Research Outreach	24	11.2	11.2	63.1
Others	79	36.9	36.9	100.0
Total	214	100.0	100.0	

The results in Table 5.2 indicate that 18(8.4%) were working in the Agric Econs and Extension Programme, 29(13.6%) in the farming system, while 26(12.1%) were working in the Biotechnology Department. The findings revealed that 38(17.8%) of the respondents were working in the product development programme and 24(11.2%) were in the research outreach departments of the institutes. The findings show that the majority 79(36.9%) of the respondents were working in other departments/programmes, which include the cassava programme, the yam programme, sweet potato, cocoyam, ginger, post-harvest, technology, maize, banana, kenaf and jute, cereals, trypanotolerant livestock, grain legumes, land and water resource management, cowpea, groundnut, cotton, confectioneries, castor and tomato programmes.

5.2.2.2 Years of working experience (N=214)

The respondents were asked to state the number of years they had worked in their present department/unit/programme. The results are presented in Table 5.3.

Table 5.3 Years of working experience (N=184)

Number of Years in this Department/Unit/Programme				
Years	**Freq**	**%**	**Valid %**	**Cumulative %**
1-3	53	24.8	28.8	28.8
4-7	45	21.0	24.5	53.3
8-11	32	15.0	17.4	70.7
12-15	35	16.4	19.0	89.7
Above 16	19	8.9	10.3	100.0
Missing Value	30	14.0		
Total	214	100.0	100.0	

The results in Table 5.3 show that 53(24.8%) had 1-3 years' experience, 45(21.0%) had working experience of 4-7 years. Thirty two (15.0%) had experience of 8-11 years and 35(16.4%) 12-15 years of working experience. Nineteen (8.9%) had more than 16 years' experience in their respective institutes. Thirty (14.0%) did not indicate their years of working experience in the institute. The respondents were not compelled to complete any segment of the instrument if they did not wish to do so.

Based on the results, it is clear that the majority of the respondents, 53(24.8%) and 45(21.0%), respectively, had work experience of between 1-3 and 4-7 years in the institutes. This finding revealed low level of productivity in the institutes, as majority of the researchers had less than 10 years of research experience.

5.2.2.3 Other departments/units/programmes worked in during the last five years (N=214)

The respondents were asked to indicate what other departments/units/programmes they had worked in during the last five years. This was to ascertain the level of knowledge and technology transfer that could have occurred in the institutes. The results are presented in Table 5.4.

Table 5.4 Other departments/units/programmes worked in during the last five years (N=62)

Other Departments/Units/Programmes Worked in Past Five Years				
Dept/Unit/Programme	**Freq**	**%**	**Valid %**	**Cumulative %**
Agric Econs & Ext Programme	6	2.8	9.7	9.7
Farming System	5	2.3	8.1	17.7
Biotechnology	11	5.1	17.7	35.5
Product Development Programme	8	3.7	12.9	48.4
Research Outreach	7	3.3	11.3	59.7
Others	25	11.7	40.3	100.0
Missing Value	152	71.0		
Total	214	100.0	100.0	

The results in Table 5.4 show that six (2.8%) worked in the Agric Econs and Extension Programme, five (2.3%) in Farming System, 11(5.1%) in the Biotechnology Department, eight (3.7%) in the Product Development Programme, seven (3.3%) in Research Outreach, while 25(11.7%) of the respondents had worked in other departments/units/programmes such as Agric Mechanization, Artemisia, Irrigation Research, Cereals Research, Legumes and Oil Seed, Land and Water Resources management. The majority of the respondents 152(71.0%) reserved comment on the department/unit they worked in during the past five years.

5.2.2.4 Position/rank of respondents (N=214)

The study sought to know the position/rank of the respondents in the institutes. The results are shown in Table 5.5.

Table 5.5 Position/rank of respondents (N=202)

Position/Rank of Respondents				
Position/rank	**Freq**	**%**	**Valid %**	**Cumulative %**
Research Officer 1&2	84	39.3	41.6	41.6
Principal Research Officer	24	11.2	11.9	53.5
Principal Laboratory Technologist	25	11.7	12.4	65.8
Senior Research Officer	35	16.4	17.3	83.2
Professor	11	5.1	5.4	88.6
Others	23	10.7	11.4	100.0
Missing Value	12	5.6		
Total	214	100.0	100.0	

The distribution of respondents in Table 5.5 by position/rank showed that 84(39.3%) were at the rank of either research officer I or research officer II, 24(11.2%) were principal research officers, while 25(11.7%) were principal laboratory technologists. Thirty five (16.4%) were senior research officers, 11(5.1%) professors and 23 others (10.7%) were assistant directors, directors, research coordinators, junior research fellows, senior agricultural superintendents, station managers and senior farm assistants I & II. However, 12(5.6%) of the respondents did not indicate their rank. This is without prejudice to their right of not responding to any issue.

5.2.2.5 Age of respondents (N=214)

This segment provides the age groups of respondents of the five institutes involved in the study. Table 5.6 indicates the results

Table 5.6 Age of Respondents (N=197)

Age of Respondents				
Age	**Freq**	**%**	**Valid %**	**Cumulative %**
18-28	34	15.9	17.3	17.3
29-38	57	26.6	28.9	46.2
39-48	59	27.6	29.9	76.1
49-58	40	18.7	20.3	96.4
58 Above	7	3.3	3.6	100.0
Missing Value	17	7.9		
Total	214	100.0	100.0	

The responses revealed that 59(27.6%) were in the category of 39-48 years, followed by 57(26.6%) in the age bracket of 29-38 years, while 40(18.7%) were 49-58 years of age. It is evident from the findings that 34(15.9%) were between 18 and 28 years, 17(7.9%) did not indicate their age, and seven (3.3%) were 58 years old or older. The majority of the respondents were thus 29 years and above.

5.2.2.6 Gender of respondents (N=214)

The respondents were asked to indicate their gender. The results are found in Table 5.7.

Table 5.7 Gender of respondents (N=208)

Gender of Respondents				
Gender	**Freq**	**%**	**Valid %**	**Cumulative %**
Male	151	70.6	72.6	72.6
Female	57	26.6	27.4	100.0
Missing Value	6	2.8		
Total	214	100.0	100.0	

The distribution of researchers on the basis of gender revealed that 151(70.6%) were males and 57(26.6%) were females, six 6(2.8%) did not indicate their gender. The overall results show that the majority of the respondents were males.

5.2.2.7 Educational status of respondents (N=214)

The researcher wanted to know the educational status/qualification of the respondents in the five research institutes. The results are given in Table 5.8.

Table 5.8 Educational status of respondents (N=207)

Educational Status of Respondents				
Educational Status	**Freq**	**%**	**Valid %**	**Cumulative %**
Diploma/HND/NCE	32	15.0	15.5	15.5
Bachelor's Degree	51	23.8	24.6	40.1
Master's Degree	62	29.0	30.0	70.0
PhD	62	29.0	30.0	100.0
Missing Value	7	3.3		
Total	214	100.0	100.0	

The educational status of the respondents in Table 5.8 was that 32(15.0%) were diploma/NHD/NCE holders, 51(23.8%) had a primary degree and 62(29.0%) had Master's degrees. Sixty two (29.0%) had a PhD, while seven (3.3%) of the respondents did not state their academic status. The distribution of respondents' academic status shows that the majority of the respondents were holders of Master's Degrees or higher.

5.2.3 Types of knowledge generated

The study sought to discover the types of knowledge generated in the five agricultural research institutes.

5.2.3.1 Knowledge generated by the research institutes

The findings revealed that the following specific knowledge is generated in the institute to stimulate agricultural development in the country:

- Genetic improvement of varieties of cereals, crops, roots, tubers, barley, wheat, rice, soybeans, sugarcane, beniseed and millet
- Crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation
- Crop improvement and management practices
- Generation of agricultural technologies and management practices
- Pest management, agronomic practices and improved seeds
- Fish production and management practices

5.2.3.2 Level of the knowledge production (N = 214)

The researcher wanted to determine the level at which knowledge was produced by the five institutes. The results are given in Table 5.9.

Table 5.9 Level of the knowledge production (N=214)

Rate the Level of Knowledge Production				
Responses	**Freq**	**%t**	**Valid %**	**Cumulative %**
Very low	4	1.9	1.9	1.9
Low	9	4.2	4.2	6.1
High	120	56.1	56.1	62.1
Very high	81	37.9	37.9	100.0
Total	214	100.0	100.0	

The results in Table 5.9 indicate the level of knowledge production, with the following responses: 4(1.9%) very low, 9(4.2%) low, 120(56.1%) high, while 81(37.9%) believed that the level of knowledge production was very high. The findings show that most of the respondents were of the view that the level of the knowledge production in their institutes was high or very high

5.2.3.3 Comparison of explicit knowledge generation and tacit knowledge generation in the institutes (N=214)

The respondents were asked to compare the generation of knowledge through interaction (tacit knowledge) and generation of knowledge through documented sources (explicit), such as manuals, reports, research guides and blueprint, in the institutes. The findings are shown in Table 5.10.

Table 5.10 Generation of explicit knowledge versus tacit knowledge (N=214)

Explicit Knowledge (N=206)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Very Low	5	2.3	2.4	2.4
Low	45	21.0	21.8	24.3
High	102	47.7	49.5	73.8
Very High	54	25.2	26.2	100.0
Missing value	8	3.7		
Total	214	100.0	100.0	
Tacit Knowledge (N=207)				
Very Low	8	3.7	3.9	3.9
Low	48	22.4	23.2	27.1
High	99	46.3	47.8	74.9
Very High	52	24.3	25.1	100.0
Missing value	7	3.3		
Total	214	100.0	100.0	

The results in Table 5.10 show: very low 5(2.3%) explicit, 8(3.7%) tacit; low 45(21.0%) explicit, 48(22.4%) tacit; high 102(47.7%) explicit, 99(46.3) tacit; very high 54(25.2%) explicit, 52(24.3%) tacit. As is evident from the results, the research institutes generated the two types of knowledge with similar intensity, because the majority of the responses were either high or very high with regard to the level of generation.

Based on the Chi-Square test the findings revealed that I. A. R. Zaria generated high level of explicit knowledge as well as tacit knowledge, followed by N. R. C. R. I. Umudike (see Table 5.35 and Table 5.36 respectively).

5.2.4 Extent of knowledge production

This section investigates the extent of knowledge production in the five agricultural research institutes.

5.2.4.1 Modes of knowledge production

The study revealed that knowledge is produced in the five research institutes through the following ways:

- Formal and informal interactions
- Mentoring
- Research, teaching and experiments
- Workshops, seminars and conferences
- Training and re-training
- Annual review meetings
- Adaptive research
- Cropping scheme meetings

5.2.4.2 Regularity of knowledge production (N=214)

The research wanted to determine how regularly the institutes produced knowledge for the agricultural sector and for overall national development. The results are shown in Table 5.11.

Table 5.11 Regularity of knowledge production (N=212)

Regularity of Knowledge Production in the Institutes				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Rarely	1	0.5	0.5	0.5
Occasionally	16	7.5	7.5	8.0
Regularly	115	53.7	54.2	62.3
Very regularly	80	37.4	37.7	100.0
Missing value	2	0.9		
Total	214	100.0	100.0	

The distributions of regularity of knowledge production (Table 5.11) show that: 1(0.5%) rarely, 16(7.5%) occasionally, while 115(53.7%) responded that the production was regular. The results indicate that 80(37.4%) were of the opinion that the production of knowledge was very regularly produced, while 2(0.9%) did not respond to the question. The overall assessment was that knowledge production in the institutes was regular.

5.2.4.3 Frequency of knowledge production in the institutes

The respondents were asked to indicate the frequency of knowledge production in the institutes. The results are shown in Table 5.12.

Table 5.12 Frequency of knowledge production (N=212)

Frequency of Knowledge Production in the Institutes				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Rarely	1	0.5	0.5	0.5
Occasionally	5	2.3	2.4	2.8
Frequently	110	51.4	51.9	54.7
Very frequently	96	44.9	45.3	100.0
Missing value	2	0.9		
Total	214	100.0	100.0	

The distribution on the basis of the extent of knowledge production in the institutes (Table 5.12) was that 1(0.5%) responded rarely, 5(2.3%) occasionally, 110(51.4%) frequently, while 96(44.9%) opined that the knowledge production was very frequent. Another 2(0.9%) of the respondents did not indicate their views.

There was a general view that knowledge was often produced. This corroborates Table 5.11, where the majority of respondents believed that knowledge production was regular.

5.2.4.4 Knowledge management activities performed in the institutes

The respondents were asked to identify the knowledge management activities performed in their research institutes. The findings are given in Table 5.13.

Table 5.13 Knowledge management activities (N=214)

KM Activities	Responses							
	Performed		Not Performed		Missing Value		Total	
	Freq	%	f	%	F	%	f	%
Knowledge Identification	200	93.5	5	2.3	9	4.2	214	100.0
Knowledge Acquisition	202	94.4	4	1.9	8	3.7	214	100.0
Knowledge Creation	197	92.1	7	3.3	10	4.7	214	100.0
Knowledge Organisation	180	84.1	27	12.6	7	3.3	214	100.0
Knowledge Transfer	194	90.7	14	6.5	6	2.8	214	100.0
Knowledge Application	203	94.9	5	2.3	6	2.8	214	100.0
Knowledge Adoption	203	94.9	4	1.9	7	3.3	214	100.0

Table 5.13 shows that respondents noted: knowledge identification 200(93.5%) performed, while 5(2.3%) responded not performed; knowledge acquisition 202(94.4%) performed, 4(1.9) not performed; knowledge creation 197(92.1%) believed is performed, while 7(3.3%) opined is not performed; knowledge organisation 180(84.1%) responded performed and 27(12.6%) indicated not performed; knowledge transfer 194(90.7%) agreed is performed, while 14(6.5%) believed not performed; knowledge application 203(94.9%) said is performed and 5(2.3%) said is not performed; knowledge adoption 203(94.9%) had the view that it is performed, while 4(1.9%) responded not performed.

The findings were that the majority of the KM activities were responded in the affirmative by the respondents and this position vindicated their status as knowledge production agencies.

5.2.4.5 Activities that lead to knowledge production

The respondents were asked to indicate the activities that lead to the production of knowledge and frequency in their institutes. The findings are presented in Table 5.14.

Table 5.14 Activities that lead to knowledge production in the institutes (N=214)

Interpersonal Discussion with Colleagues (N=213)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Never	0	0	0	0
Sometimes	4	1.9	1.9	1.9
Occasionally	29	13.6	13.6	15.5
Frequently	115	53.7	54.0	69.5
Very frequently	65	30.4	30.5	100.0
Missing value	1	0.5		
Total	214	100.0	100.0	
Workshops, Seminars and Conferences (N=211)				
Never	0	0	0	0
Sometimes	1	.5	.5	.5
Occasionally	39	18.2	18.5	19.0
Frequently	104	48.6	49.3	68.2
Very frequently	67	31.3	31.8	100.0
Missing value	3	1.4		
Total	214	100.0	100.0	
Research and Consultancy (N=210)				
Never	0	0	0	0
Sometimes	2	0.9	1.0	1.0
Occasionally	18	8.4	8.6	9.5
Frequently	83	38.8	39.5	49.0
Very frequently	107	50.0	51.0	100.0
Missing value	4	1.9		
Total	214	100.0	100.0	
Memos, Reports and Files (N=208)				
Never	0	0	0	0
Sometimes	19	8.9	9.1	9.1
Occasionally	50	23.4	24.0	33.2
Frequently	84	39.3	40.4	73.6
Very frequently	55	25.7	26.4	100.0
Missing value	6	2.8		
Total	214	100.0	100.0	
Publications such as Magazines, Newsletters (N=212)				
Never	1	0.5	0.5	.5
Sometimes	21	9.8	9.9	10.4
Occasionally	67	31.3	31.6	42.0

Frequently	81	37.9	38.2	80.2
Very frequently	42	19.6	19.8	100.0
Missing value	2	.9		
Total	214	100.0	100.0	
Online and Offline Database Search (N=208)				
Never	2	0.9	1.0	1.0
Sometimes	25	11.7	12.0	13.0
Occasionally	56	26.2	26.9	39.9
Frequently	85	39.7	40.9	80.8
Very frequently	40	18.7	19.2	100.0
Missing value	6	2.8		
Total	214	100.0	100.0	

The results in Table 5.14 identify the activities that led to the production of knowledge in the institutes. Based on the activities: interpersonal discussion with colleagues was cited by 65(30.4%) as very frequently, while 115(53.7%) said frequently, 29(13.6%) occasionally, 4(1.9%) sometimes; workshops, seminars, and conferences 67(31.3%) very frequently, 104(48.6%) frequently, 39(18.2%) occasionally and 1(0.5%) sometimes; research and consultancy 107(50.0%)very frequently, 83(38.8%) frequently, 18(8.4%) occasionally, 2(0.9%) sometimes; memos, reports and files 55(25.7%) very frequently, 84(39.3%) frequently, 18(8.4%) occasionally, 2(0.9%) sometimes; publications such as magazines, newsletters, bulletins etc. 42(19.6%) very frequently, 81(37.9%) frequently, 67(31.3%) occasionally, 21(9.8%) sometimes, while 1(0.5%) responded never; online and offline database search 40(18.7%) very frequently, 85(39.7%) frequently, 56(26.2%) occasionally, 25(11.7%), while 2(0.9%) opined never happened.

The results show that all the activities that lead to knowledge production are performed frequently, especially interpersonal discussion with colleagues, workshops, seminars and conferences, research and consultancy and memos, reports and files management.

5.2.4.6 Sharing of information, ideas, expertise and experience with colleagues

The research sought to know whether or not the respondents shared knowledge with colleagues for enhanced knowledge production in the institutes. The findings are shown in Figure 5.1.

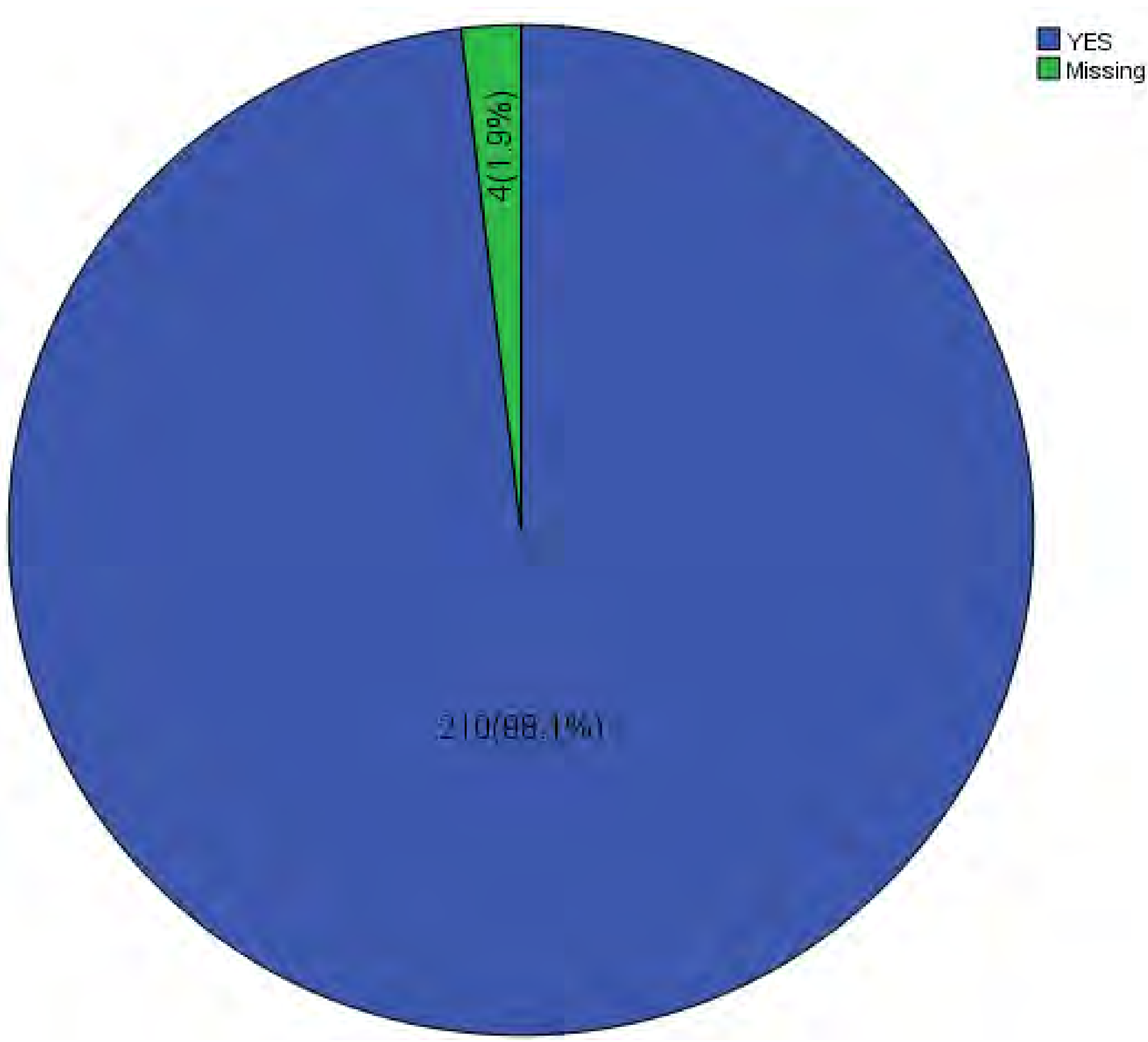

Figure 5.1 Sharing of information, ideas, expertise and experience with colleagues (N=210)

Figure 5.1 shows that the distribution of knowledge sharing in the institutes. Two hundred and ten (98.1%) claimed that they shared expertise, ideas and knowledge with colleagues, while 4(1.9%) did not respond. The results show that knowledge sharing is the norm in the five research institutes.

5.2.4.7 Category of staff with whom knowledge is shared

The respondents were asked to state the category of staff they share knowledge with from among the junior, senior or all staff in the institutes. The results are shown in Figure 5.2.

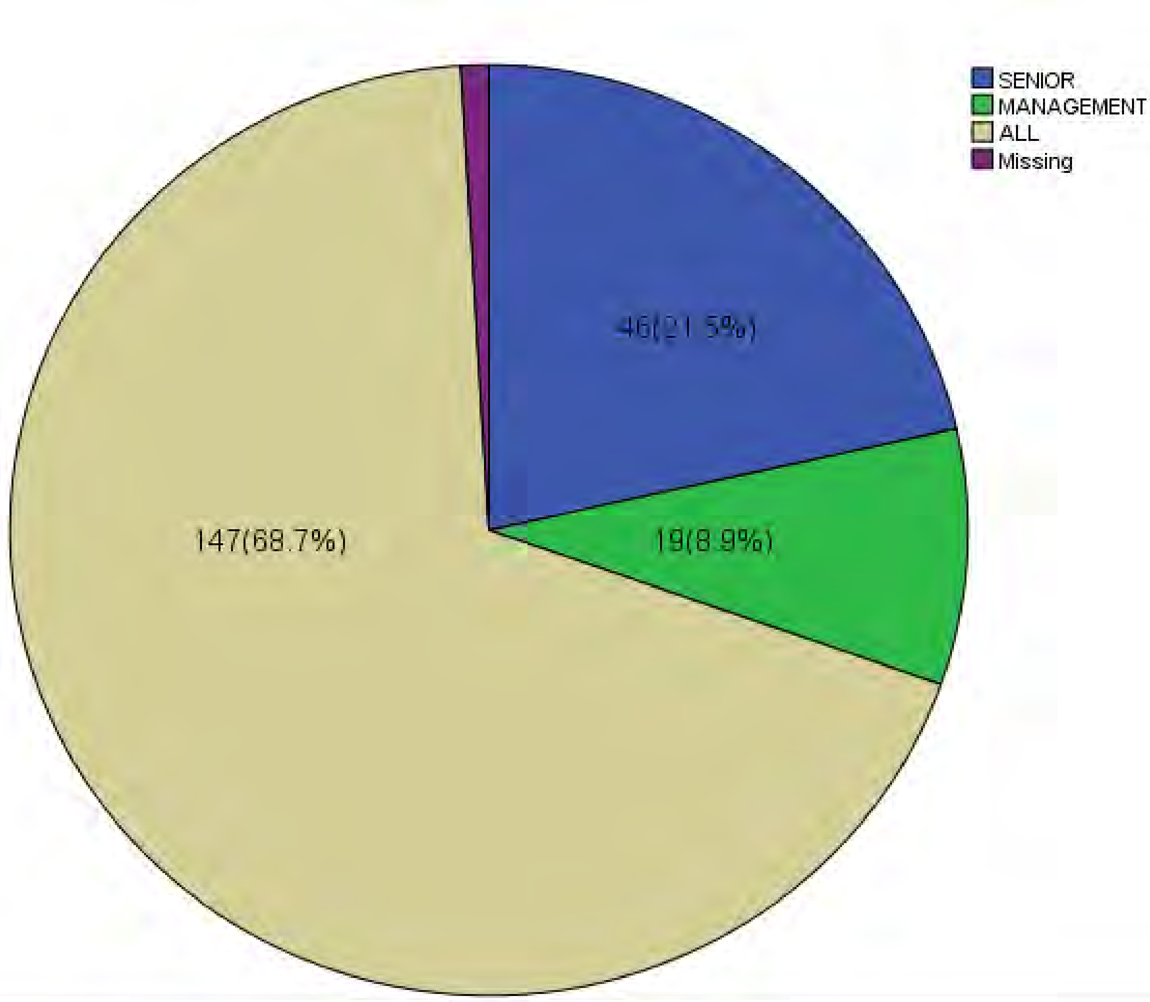

Figure 5.2 Category of staff sharing knowledge (N=212)

The results in Figure 5.2 typify the knowledge sharing phenomenon in the five research institutes. The responses show that 46(21.5%) of the staff shared knowledge with senior staff, 19(8.9%) shared with management and 147(68.7) normally shared their knowledge with all the categories of staff, i.e. both management and other senior staff in both formal and informal fora such as offices, laboratories, meetings, workshops and seminars.

5.2.4.8 Training, seminar and workshops for capacity building

The researcher wanted to know if training, seminars and workshops were organized in the institute to enhance the capacity of staff for improved performance. The findings are summerised in Table 5.15

Table 5.15 Training, seminars and workshops for capacity building (N=209)

Training, Seminars and Workshops for Capacity Building on KM				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
No	9	4.2	4.3	4.3
Yes	200	93.5	95.7	100.0
Missing value	5	2.3		
Total	214	100.0	100.0	

The findings show that 200(93.5%) agreed training, seminars and workshops were organised, while 9(4.2%) of the respondents said the programmes were not available in their institutes. Five (2.3%) did not state their opinion.

5.2.4.9 Number of trainings, seminars and workshops attended in the past one year

The respondents were asked to indicate the number of trainings, seminars and workshops attended in the past five years. The results are shown in Table 5.16.

Table 5.16 Number of trainings, seminars and workshops attended (N=211)

Number of Training, Seminars and Workshops attended in the Past Five Years				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
None	26	12.1	12.3	12.3
Once	76	35.5	36.0	48.3
Twice	50	23.4	23.7	72.0
Three times	36	16.8	17.1	89.1
Four times	22	10.3	10.4	99.5
More than four times	1	0.5	0.5	100.0
Missing value	3	1.4		
Total	214	100.0	100.0	

Table 5.16 shows the distribution of seminars, training sessions and workshops attended in the last five years by the researchers of the five institutes. The responses were as follows: 26(12.1%) indicated none, 76(35.5%) had attended one, 50(23.4%) two and 36(16.8%) of the respondents attended three times in the past one year. The results indicated that 22(10.3%) had attended four times within the period, while 1(0.5%) claimed to have attended more than four times in the past year. Three (1.4%) of the respondents did not respond.

The findings largely reveal that there was no frequent training, seminar and workshop attendance by researchers in the institutes.

5.2.4.10 Frequency of research and development activities in the institutes

The researcher wanted to determine the frequency of research and development activities, to ascertain and buttress the knowledge production activities in the institutes. The findings are indicated in Figure 5.3.

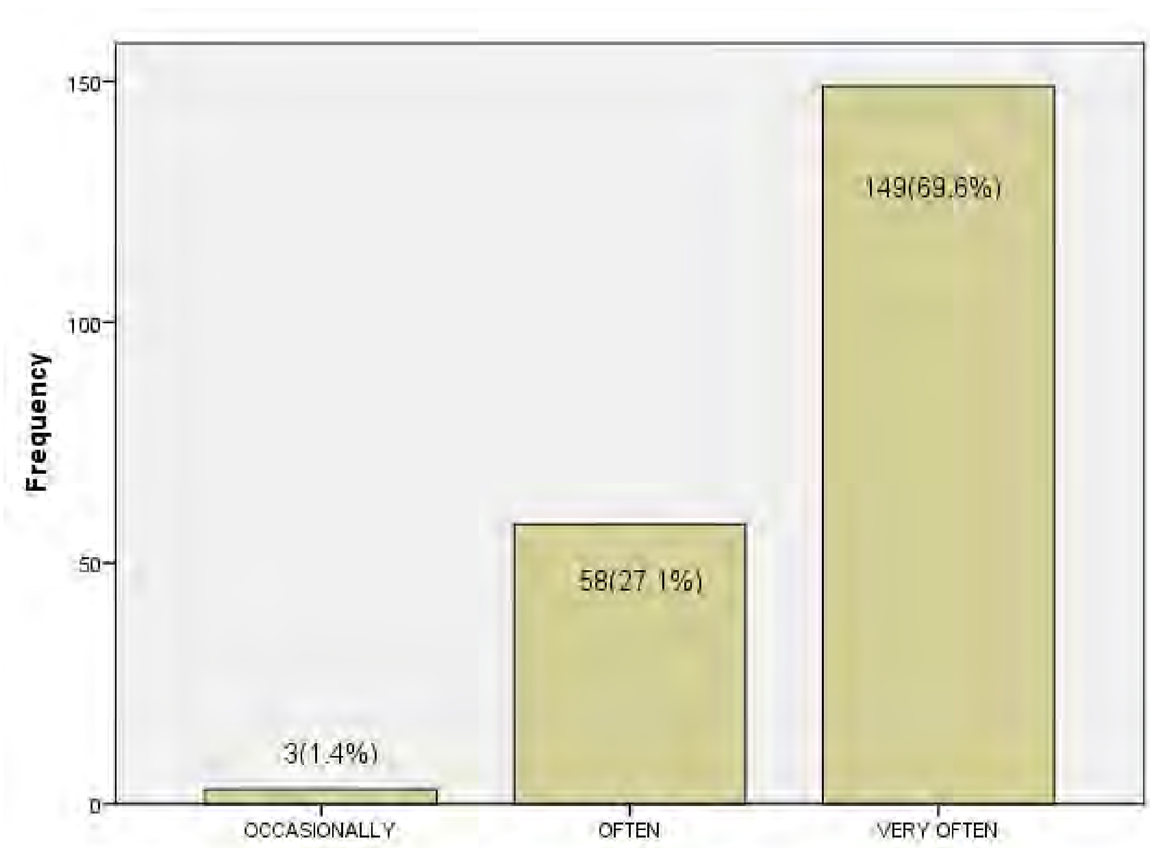

Figure 5.3 Frequencies of research and development activities in the institutes (N=210)

The responses in Figure 5.3 typify the rate at which the institutes engaged in research and development activities for knowledge production to facilitate agricultural development. The results show that 3(1.4%) of the respondents indicated that the conduct of research and development activities was occasional, 58(27.1%) claimed that it is often and 149(69.6%) that research and development activities were conducted very often in the institutes. Based on the results, the majority of the respondents believed that research and development activities were often and very often conducted. This result is concurrent with the statutory responsibilities of the institutes.

5.2.5 Knowledge management strategies

This section investigates the knowledge management strategies used in the five agricultural research institutes to derive research and innovation.

5.2.5.1 Knowledge management best practices adopted

The respondents were asked to indicate the knowledge management best practices adopted in their institutes for efficient knowledge management. The findings are shown in Table 5.17.

Table 5.17 Knowledge management best practice adopted in the institutes

Community of Practice (N=211)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Not adopted	87	40.7	41.2	41.2
Adopted	124	57.9	58.8	100.0
Missing value	3	1.4		
Total	214	100.0	100.0	
Community of Knowledge (N=207)				
Not adopted	91	42.5	44.0	44.0
Adopted	116	54.2	56.0	100.0
Missing value	7	3.3		
Total	214	100.0	100.0	

Table 5.17 shows the responses regarding the knowledge management best practices adopted in the five institutes. The respondents who noted that community of practice was not adopted numbered 87(40.7%), while 124(57.9%) said it was adopted, 3(1.4%) did not respond; community of knowledge 91(42.5%) not adopted, 116(54.2) adopted and 7(3.3%) abstained from giving a response. It can be surmised that both two knowledge management best practices had been adopted in the research institutes.

5.2.5.2 Knowledge management resources and techniques

The respondents were asked to identify the KM resources and techniques commonly used in their institutes to derive research and innovation. The results are shown in Table 5.18.

Table 5.18 Knowledge Management Resources and Techniques Available

Cross-Functional Project Teams (N=209)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Not available	69	32.2	33.0	33.0
Available	140	65.4	67.0	100.0
Missing value	5	2.3		
Total	214	100.0	100.0	
KM Training and Education (N=213)				
Not available	109	50.9	51.2	51.2
Available	104	48.6	48.8	100.0
Missing value	1	0.5		
Total	214	100.0	100.0	
Storytelling (N=209)				
Not available	191	89.3	91.4	91.4
Available	18	8.4	8.6	100.0
Missing value	5	2.3		
Total	214	100.0	100.0	
Mentoring (N=211)				
Not available	84	39.3	39.8	39.8
Available	127	59.3	60.2	100.0
Missing value	3	1.4		
Total	214	100.0	100.0	

Table 5.18 shows the KM resources and techniques used as KM strategies by organisations to enhance productivity and output. The responses were as follows: cross-functional project teams 69(32.2%) not available, 140(65.4%) available and 5(2.3%) did not respond; KM training and education 109(50.9%) claimed not available, 104(48.6%) said it was available, and 1(0.5%) abstained from commenting; storytelling 191(89.3%) said not available, 18(8.4%) said it was available, while 5(2.3%) did not comment; mentoring 84(39.3%) not available, 127(59.3) claimed mentoring was available and 3(1.4%) abstained.

Generally, the results show that cross-functional project teams and mentoring were available in the institutes, while storytelling and KM training and education were not available.

5.2.5.3 Knowledge management initiatives

The researcher wanted to know the KM initiatives adopted by the research institutes for proper management of knowledge. The results are shown in Table 5.19.

Table 5.19 Knowledge management initiatives available (N=206)

KM Initiatives	Responses							
	Available		Not Available		Missing Value		Total	
	Freq	%	f	%	F	%	f	%
Identification of Existing Knowledge	190	88.8	16	7.5	8	3.7	214	100.0
Improved Documentation of Existing Knowledge	203	94.9	5	2.3	6	2.8	214	100.0
Changing of the Organisational Culture	117	54.7	83	38.8	14	6.5	214	100.0
Improving Co-operation and Communication	186	86.9	17	7.9	11	5.1	214	100.0
Externalisation: turn tacit to explicit	136	63.6	59	27.6	19	8.9	214	100.0
Improving Training, Education and Networking of Newly Recruited Employees	193	90.2	14	6.5	7	3.3	214	100.0
Improving Training and Education of all Employees	183	85.5	27	12.6	4	1.9	214	100.0
Improving Retention of Knowledge	175	81.8	20	9.3	19	8.9	214	100.0
Improving Access to Existing Sources of Knowledge	197	92.1	8	3.7	9	4.2	214	100.0
Improving Acquisition or Purchasing of External Knowledge	143	66.8	57	26.6	14	6.5	214	100.0
Improving Distribution of Knowledge	184	86.0	25	11.7	4	1.9	214	100.0
Improving Management of Innovations	178	83.2	30	14.0	6	2.8	214	100.0
Reduction of Costs	110	51.4	84	39.3	20	9.3	214	100.0

The distribution of KM initiatives available (Table 5.19) in the institutes show that respondents who noted identification of existing knowledge was not available were 190(88.8%), while 16(7.5%) claimed it was available; improved documentation of existing knowledge 203(94.9%) available, and 5(2.3%) opined not available; changing of the organisational culture 117(54.7%) was available, 83(38.8) not available; improved co-operation and communication 186(86.9%) of the respondents claimed was available, while 17(7.9%) described as not available;

externalisation 136(63.6%) available, while 59(27.6%) had claimed not available; improving training, education and networking of newly recruited employees 193(90.2%) were of the view that it was available, while 14(6.5%) answered not available; improving training and education of all employees 183(85.5%) said not available, and 27(12.6%) of the respondents believed it was not available; improving retention of knowledge 175(81.8%) opined was available, while 20(9.3%) said not available; improving access to existing sources of knowledge 197(92.1%) believed was available and 8(3.7%) said was not available; improving acquisition or purchasing of external knowledge 143(66.8%) available, while 57(26.6%) not available; improving distribution of knowledge 184(86.0%) of the respondents believed was available and 25(11.7%) said it was not available; improving management of innovations 178(83.2%) available, 30(14.0%) not available; reduction of costs 110(51.4%) claimed was available, while 84(39.3%) believed it was not available.

The findings generally suggest that all the KM initiatives were available in the five agricultural research institutes.

5.2.5.4 Knowledge management strategy used

The researcher sought to know the KM strategy mostly used in the five research institutes between system strategy and human strategy. System strategy is also known as codification strategy, where ICT facilities are used in the generation, classification, sorting, storage and communication of knowledge, such as document management systems, expert systems and groupware. While human strategy, also called personalisation strategy, involved human interaction through sharing of tacit knowledge via formal and informal meetings which have the capacity for knowledge generation and dissemination. The results are shown in Table 5.20

Table 5.20 Knowledge management strategy used by the institutes

System Strategy: ICT-Based (N=209)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Not available	103	48.1	49.3	49.3
Available	106	49.5	50.7	100.0
Missing value	5	2.3		
Total	214	100.0	100.0	
Human Strategy: Social Network and Interaction (N=205)				
Not available	53	24.8	25.9	25.9
Available	152	71.0	74.1	100.0
Missing Value	9	4.2		
Total	214	100.0	100.0	

Table 5.20 reveals responses as follows: on system strategy 103(48.1%) of the respondents said it was not available, while 106(49.5%) said it was available and 5(2.3%) did not comment; human strategy 53(24.8%) said it was not available, 152(71.0%) believed it was available and practised, while 9(4.2%) abstained from commenting on the issue. Even though the findings show that both strategies were available and used in the five institutes, human strategy was more used, as shown by the results through interactions and social networking.

5.2.5.5 Skills for knowledge management

The respondents were asked to identify the skills available for the management of knowledge in their institutes. The findings are shown in Table 5.21.

Table 5.21 Skills for knowledge management available (N=204)

KM Skills	**Responses**							
	Available		**Not Available**		**Missing Value**		**Total**	
	Freq	**%**	**f**	**%**	**f**	**%**	**f**	**%**
Processing Factual and Theoretical Knowledge	150	70.1	49	22.9	15	7.0	214	100.0
Finding and Accessing Knowledge	189	88.3	11	5.1	14	6.5	214	100.0
Ability to Apply Knowledge	200	93.5	2	0.9	12	5.6	214	100.0
Knowledge Integration and Re-combination	149	69.6	55	25.7	10	4.7	214	100.0

Table 5.21 shows the KM skills available in the five institutes. Based on the results: processing factual and theoretical knowledge 150(70.1%) of respondents said it was available, while 49(22.9%) of the respondents claimed it was not available; finding and accessing knowledge 189(88.3%) believed it was available, while 11(5.1%) respondents said it was not available; ability to apply knowledge 200(93.5%) respondents said it was available, while 2(0.9%) said it was not available; knowledge integration and re-combination 149(69.6%) claimed it was available, while 55(25.7%) said it was not available and 10(4.7%) did not comment on the matter.

5.2.5.6 Specialists for knowledge management systems

The researcher investigated the availability or otherwise of specialists for handling the KM systems in the five research institutes. The findings are presented in Table 5.22.

Table 5.22 Specialists for knowledge management systems in the institutes (N=213)

Specialists	Responses							
	Available		Not Available		Missing Value		Total	
	f	%	F	%	f	%	f	%
Network Administrator	110	51.4	104	48.6	-	-	214	100.0
Database Administrator	127	59.3	87	40.7	-	-	214	100.0
Maintenance Technician	161	75.2	53	24.8	-	-	214	100.0
Data Entry Operator	176	82.2	37	17.3	1	.5	214	100.0

Table 5.22 depicts the specialists available for handling the KM systems in the five research institutes. The responses were as follows: network administrator 110(51.4%) of the respondents claimed was available, while 104(48.6%) said was not available; database administrator 127(59.3%) said was available, while 87(40.7%) believed was not available; maintenance technician 161(75.2%) responded was available, while 53(24.8%) said was not available; data entry operator 176(82.2%) said was available, while 37(17.3%) of the respondents said was not available. An overall assessment revealed that all the experts were available for handling the KM systems in the five research institutes.

5.2.6 Knowledge dissemination

This section deals with the dissemination of knowledge in the five research institutes for increased productivity and know-how.

5.2.6.1 Availability and accessibility of sources of knowledge

The respondents were asked to identify which of the following source(s) of knowledge was available and accessible in their institutes. The results are shown in Table 5.23.

Table 5.23 Availability and accessibility of knowledge

Experience of Staff Who Have Retired From Service (N=214)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Not available	24	11.2	11.2	11.2
Available but not accessible	83	38.8	38.8	50.0
Available and accessible	107	50.0	50.0	100.0
Total	214	100.0	100.0	
Experience of Staff Who Are Transferred to Your Dept/Unit (N=214)				
Not available	20	9.3	9.3	9.3
Available but not accessible	60	28.0	28.0	37.4
Available and accessible	134	62.6	62.6	100.0
Total	214	100.0	100.0	
Experience of Staff Who Are Transferred from Your Dept/Unit (N=214)				
Not available	1	0.5	0.5	0.5
Available but not accessible	33	15.4	15.4	15.9
Available and accessible	180	84.1	84.1	100.0
Total	214	100.0	100.0	
Minutes of Meetings (N=214)				
Not available	11	5.1	5.1	5.1
Available but not accessible	72	33.6	33.6	38.8
Available and accessible	131	61.2	61.2	100.0
Total	214	100.0	100.0	
Research Findings/Results (N=214)				
Not available	1	0.5	0.5	0.5
Available but not accessible	45	21.0	21.0	21.5
Available and accessible	168	78.5	78.5	100.0
Total	214	100.0	100.0	
Internal/External Memos (N=214)				
Not available	27	12.6	12.6	12.6
Available but not accessible	79	36.9	36.9	49.5
Available and accessible	108	50.5	50.5	100.0
Total	214	100.0	100.0	
Official Letters/Files (N=214)				
Not available	24	11.2	11.2	11.2
Available but not accessible	91	42.5	42.5	53.7
Available and accessible	99	46.3	46.3	100.0
Total	214	100.0	100.0	

Table 5.23 shows the availability and accessibility of the source(s) of knowledge in the five agricultural research institutes. The responses indicated that experiences (tacit knowledge) of staff who have retired from service 24(11.2%) were not available, while 83(38.8%) said they were available but not accessible, 107(50.0%) of the respondents claimed knowledge was available and accessible; the experience (tacit knowledge) of staff who are transferred to your dept./unit 20(9.3%) respondents was not available, 60(28.0%) claimed was available but not accessible, while 134(62.6%) said it was available and accessible; experience (tacit knowledge) of staff who are transferred from your dept/unit 1(0.5%) believed was not available, 33(15.4%) responded was available but not accessible, 180(84.1) said it was available and accessible; minutes of meetings (explicit knowledge) 11(5.1%) of respondents were of the opinion that they were not available, 45(21.0%) said they were available but not accessible, while 131(61.2%) responded was available and accessible in the institutes; research findings/results (explicit knowledge) 1(0.5%) respondents said they were not available, 45(21.0%) responded they were available but not accessible, while 168(78.5%) agreed they were available and accessible; internal/external memos (explicit knowledge) 27(12.6%) said were not available, 79(36.9%) claimed they were available but not accessible, while 108(50.5%) believed they were available and accessible; official letters/files (explicit knowledge) 24(11.2%) of the respondents believed they were not available, 91(42.5%) said they were available but not accessible, while 99(46.3) claimed they were available and accessible. These results reveal that all the sources of knowledge were available and accessible in the institutes. This would, in no small measure, facilitate knowledge production, communication, access and sharing.

5.2.6.2 Mode of knowledge transmission

The researcher investigated the mode of knowledge transmission and communication in the five agricultural research institutes. The results are found in figure 5.4

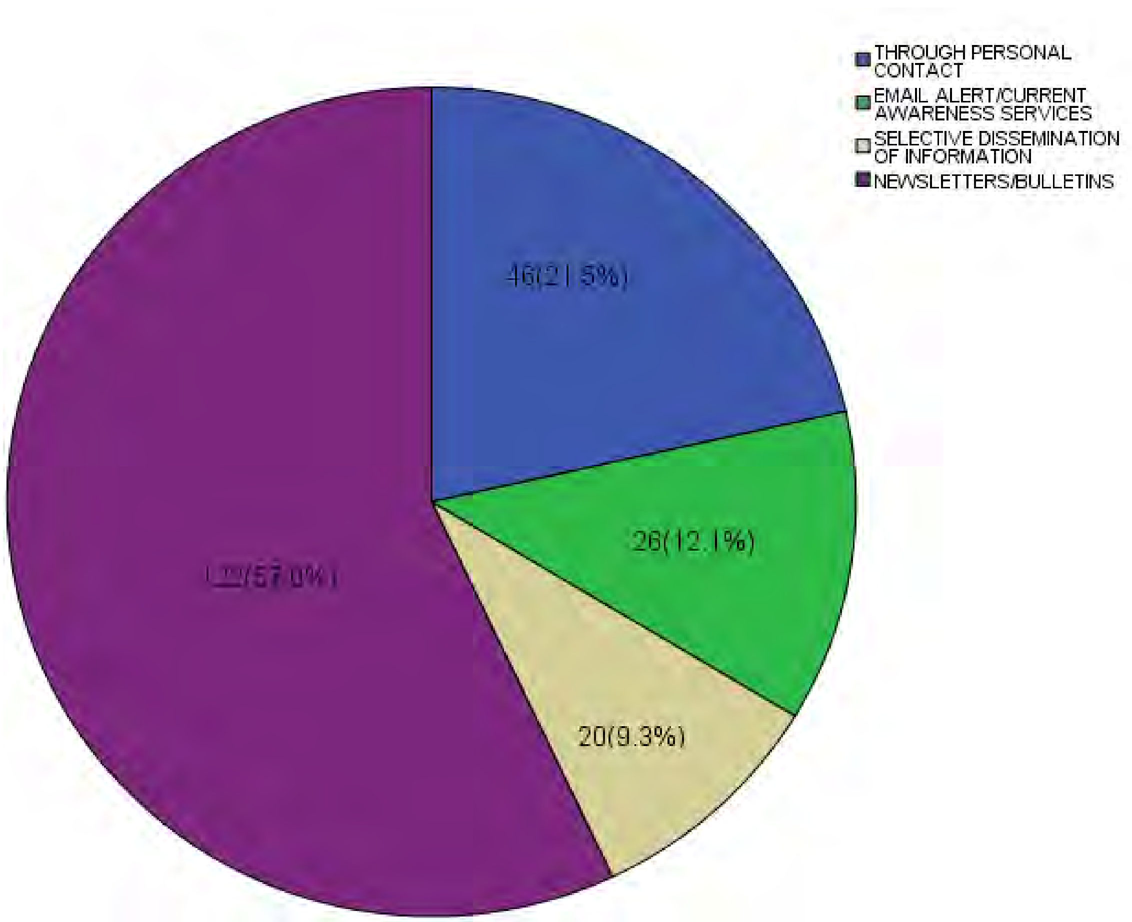

Figure 5.4 Modes of knowledge transmission in the institutes (N=214)

Figure 5.4 depicts the modes of knowledge transmission in the five research institutes. The findings show that 46(21.5%) of the respondents said the transmission was through personal contact, 26(12.1%) claimed was via e-mail alert/current awareness services, 20(9.3%) that the transmission was via selective dissemination of information, while 122(57.0%) replied that the transmission was through newsletters and bulletins. The results revealed that the majority of the respondents believed that information and knowledge transmission/communication was being carried out through newsletters and bulletins in their institutes.

5.2.6.3 Condition for accessing and utilising knowledge in the institutes

The respondents were asked to state if there were condition(s) for accessing and utilising knowledge by stakeholders. The results are shown in Figure 5.5.

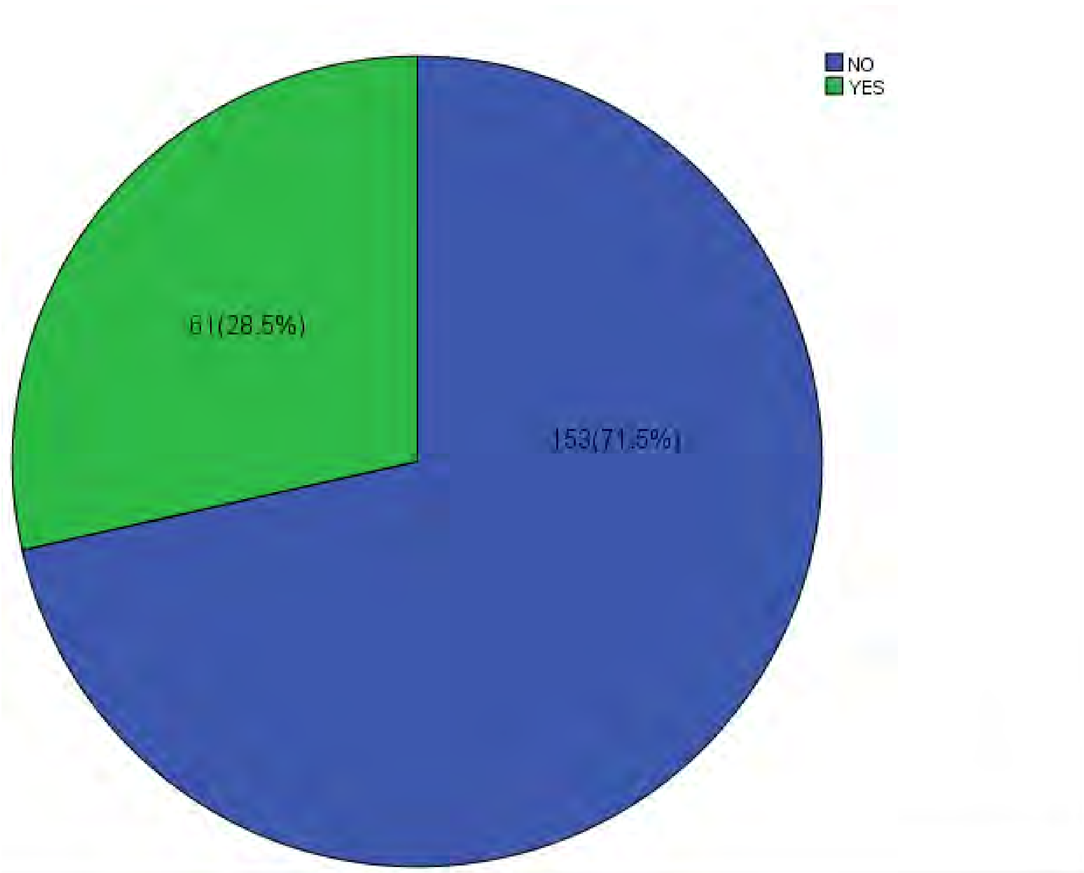

Figure 5.5 Condition(s) for accessing and utilising knowledge in the institutes (N=214)

Figure 5.5 depicts the conditions for accessing and utilising knowledge in the five research institutes. The results show that 61(28.5%) of the respondents claimed that there were conditions attached, while 153(71.5%) said there were not conditions for access and utilisation of available knowledge by the stakeholders of the institutes.

According to those who claimed there were conditions, the conditions are as follows:

- Memorandum of Understanding (MoU)
- You must register before access
- State clearly reason(s) for access and utilization

- Secure management approval
- State how the knowledge/information will be utilized

5.2.6.4 Source(s) of knowledge acquisition

The researcher sought to discover the source(s) through which the respondents acquired knowledge and information in the institutes. The results are shown in Table 5.24.

Table 5.24 Source(s) of knowledge acquisition in the institutes (N=214)

Source(s) Through Which You Acquire Knowledge in the Institutes				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Colleagues	121	56.5	56.5	56.5
Research reports and newsletters	72	33.6	33.6	90.2
Learn by doing	12	5.6	5.6	95.8
Internet and institutes' databases	9	4.2	4.2	100.0
Total	214	100.0	100.0	

Table 5.24 shows the knowledge sharing and acquisition scenario in the five research institutes. Based on the findings, 121(56.5%) respondents said they acquired knowledge through colleagues, 72(33.6%) said it was through research reports and newsletters, 12(5.6%) said through learning by doing, while 9(4.2%) of the respondents claimed they acquired knowledge via the internet and the institutes' databases. It is clear from Table 5.24 that majority of the respondents were getting knowledge through colleagues. This result suggests that the phenomenon of knowledge sharing existed in the institutes.

5.2.7 Knowledge management infrastructure

This section investigates the knowledge management infrastructure available in the five research institutes.

5.2.7.1 Document management systems

The respondents were asked to identify the document management systems available in their institutes. The findings are shown in Table 5.25.

Table 5.25 Document management systems available in the institutes (N=214)

DM Systems	Responses					
	Available		Not Available		Total	
	Freq	%	f	%	F	%
Group Directories	74	34.6	140	65.4	214	100.0
Archives	160	74.8	54	25.2	214	100.0
Other Repositories; CDs	93	43.5	121	56.5	214	100.0

Table 5.25 shows the document management systems available for knowledge management in the five research institutes. The responses are as follows: 74(34.6%) said document management systems were available, 140(65.4%) said not available; archives 160(74.8%) said were available, while 54(25.2%) claimed they were not available; other repositories such as CDs 93(43.5%) said available, while 121(56.5%) respondents said were not available in their institutes. The findings revealed that archives were available in the institutes for knowledge management activities.

5.2.7.2 Knowledge management systems

The researcher sought to establish which KM systems are available in the five research institutes. The findings are shown in Table 5.26.

Table 5.26 Knowledge management systems available in the institutes (N=214)

KM Systems	Responses					
	Available		Not Available		Total	
	Freq	%	f	%	f	%
Community of Practice	134	62.6	80	37.4	214	100.0
Personal Networks	128	59.8	86	40.2	214	100.0
Document Management System	162	75.7	52	24.3	214	100.0
Expert System	130	60.7	84	39.3	214	100.0
Organisational Practice and Routines	167	78.0	47	22.0	214	100.0
Training	197	92.1	17	7.9	214	100.0
Informal Networks	128	59.8	86	40.2	214	100.0
Groupware	53	24.8	161	75.2	214	100.0
Internet and Magazines	166	77.6	48	22.4	214	100.0

The results in Table 5.26 revealed respondents felt community of practice 134(62.6%) was available, while 80(37.4%) said it was not available; personal networks 128(59.8%) said it was available, and 86(40.2%) claimed it was not available; document management system 162(75.7%) believed was available, while 52(24.3%) said it was not available; expert system 130(60.7%) said it was available, 84(39.3%) said it was not available; organisational practice and routine 167(78.0%) agreed was available, while 47(22.0%) said was not available. The findings further show that: training 197(92.1%) of the respondents believed was available, 17(7.9%) had the opinion that it was not available; informal networks 128(59.8%) claimed was available, while 86(40.2%) said it was not available; groupware 53(24.8%) acknowledged was available, and 161(75.2%) believed was not available; internet and magazines 166(77.6%) respondents claimed was available, while 48(22.4%) stated it was not available in their institutes.

In general, all the knowledge management systems are available, with the exception of groupware, for the management of knowledge in the five institutes.

5.2.8 Factors influencing knowledge management adoption

This section deals with the factors that influence knowledge management adoption in the five research institutes.

5.2.8.1 Means of knowledge communication and transfer in the research institutes

The researcher investigated the channels/means through which the respondents communicated and transferred their knowledge to the institutes. The results are shown in Figure 5.6.

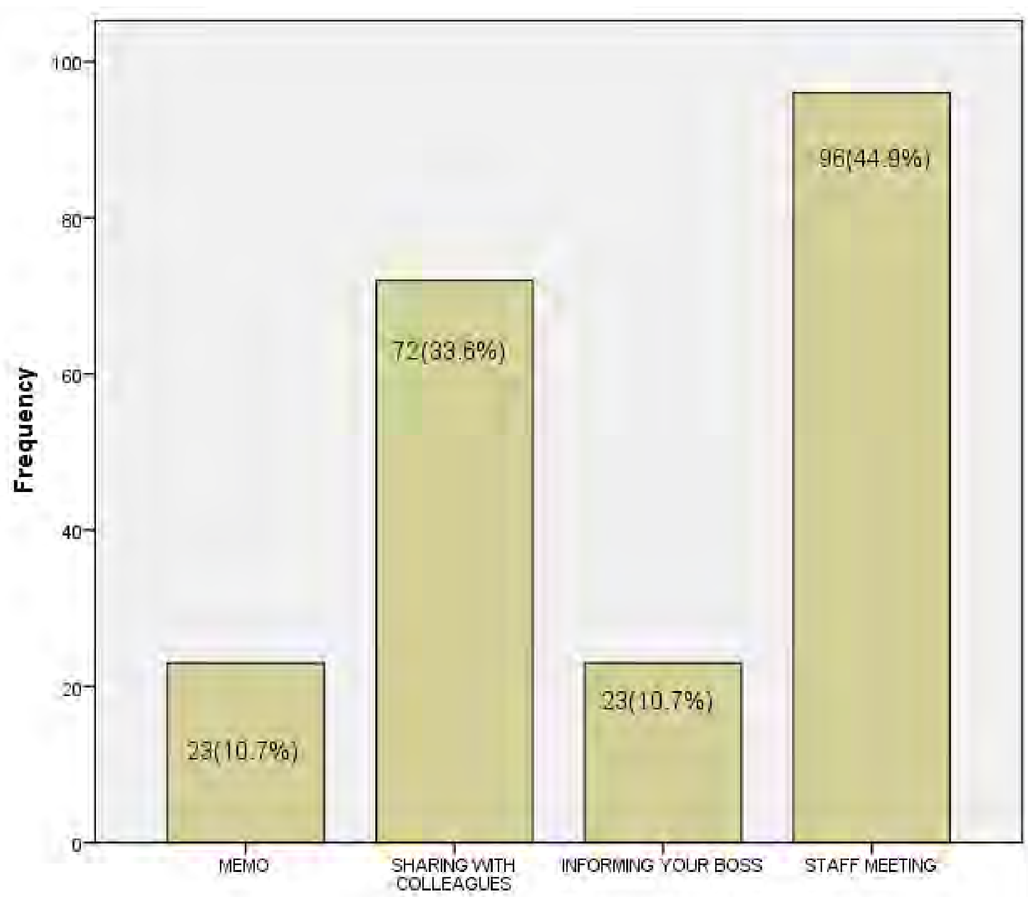

Figure 5.6 Channels/means for knowledge communication and transfer (N=214)

Figure 5.6 shows the channels through which the respondents transfer and communicate their knowledge to the institutes. Twenty-three (10.7%) of the respondents said they communicate through memos, 72(33.6%) by sharing knowledge with colleagues, 23(10.7%) inform their bosses, while 96(44.9%) respondents said they communicate their knowledge through staff meetings. Based on the results, the majority of respondents communicate their knowledge by sharing with colleagues or through staff meetings.

5.2.8.2 Knowledge sharing and knowledge sharing fora in the research institutes

The respondents were asked to state whether there is a knowledge sharing arrangement where knowledge and technology transfer takes place in their institutes. The findings are shown in Table 5.27.

Table 5.27 Knowledge sharing/knowledge Sharing fora (N=214)

Knowledge Sharing				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Yes	214	100.0	100.0	100.0
No	0	0	0	0

Table 5.27 shows that all the respondents 214(100.0%) said knowledge sharing is taking place through the holding of staff meetings in the five research institutes. This finding concurs with the results shown in Figure 5.6, in which the highest number of respondents 96(44.9%) claimed that they communicate their knowledge through staff meetings.

5.2.8.3 Regularity of holding the staff meetings

The researcher sought to know the intervals of holding staff meetings. The results are shown in Table 5.28.

Table 5.28 Regularity of holding staff meetings in the institutes (N=214)

How Often Do You Hold Staff Meetings?				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Monthly	133	62.1	62.1	62.1
Quarterly	58	27.1	27.1	89.3
Annually	23	10.7	10.7	100.0
Biannually	0	0	0	0
Total	214	100.0	100.0	

The distribution of intervals (Table 5.28) for holding meetings in the institutes show that 133(62.1%) of the respondents said the meetings are held monthly, 58(27.1%) said quarterly, while 23(10.7%) said that the meetings are held annually. No response for meetings held biannually was recorded. Based on the findings, it was surmised that the meetings were held monthly in the research institutes.

5.2.8.4 Custodian of minutes of the meetings

The respondents were asked to identify where the minutes of the meetings are kept in the five institutes. The results are shown in Figure 5.7.

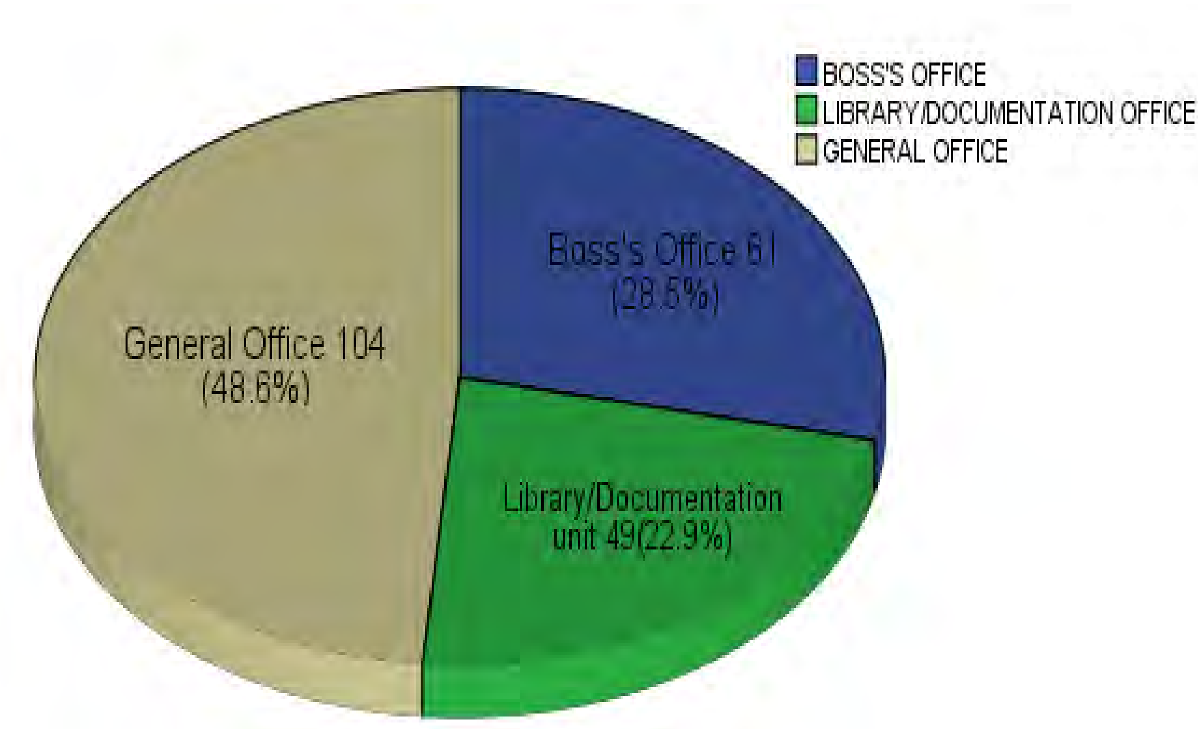

Figure 5.7 Custodians of minutes of the meetings (N=214)

Figure 5.7 shows the custodians of minutes of meetings in the five research institutes. The responses revealed that 61(28.5%) said the minutes were kept in the boss's office, 49(22.9%) in the library and documentation unit, while 104(48.6%) said the minutes were kept in the general office, where all the staff could access and review them whenever the need arose.

5.2.8.5 Working relationship

The respondents were asked to describe the soundness of the group working relationship that exists between bosses and their subordinates in the five institutes. The results are given in Table 5.29.

Table 5.29 Soundness of group work relationship (N=214)

Soundness of Group Work Relationship				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Very low	3	1.4	1.4	1.4
Low	21	9.8	9.8	11.2
Indifferent	66	30.8	30.8	42.1
High	96	44.9	44.9	86.9
Very high	28	13.1	13.1	100.0
Total	214	100.0	100.0	

Table 5.29 shows the distribution of the soundness of the group work relationship between bosses and their subordinates in the five institutes. Three (1.4%) of the respondents said it was very low, 21(9.8%) said it was low and 66(30.8%) were indifferent to the issue. Ninety-six (44.9%) respondents believed it was high, while 28(13.1%) said that the soundness of the relationship was very high. Based on the findings, the majority of the respondents had the view that the soundness of the relationship was high.

5.2.8.6 How work relationship helped in the flow and sharing of knowledge

The researcher sought to know if the soundness of the work relationship between bosses and subordinates helped the flow and sharing of information, expertise, experience and knowledge in the institutes. The results are shown in Figure 5.8.

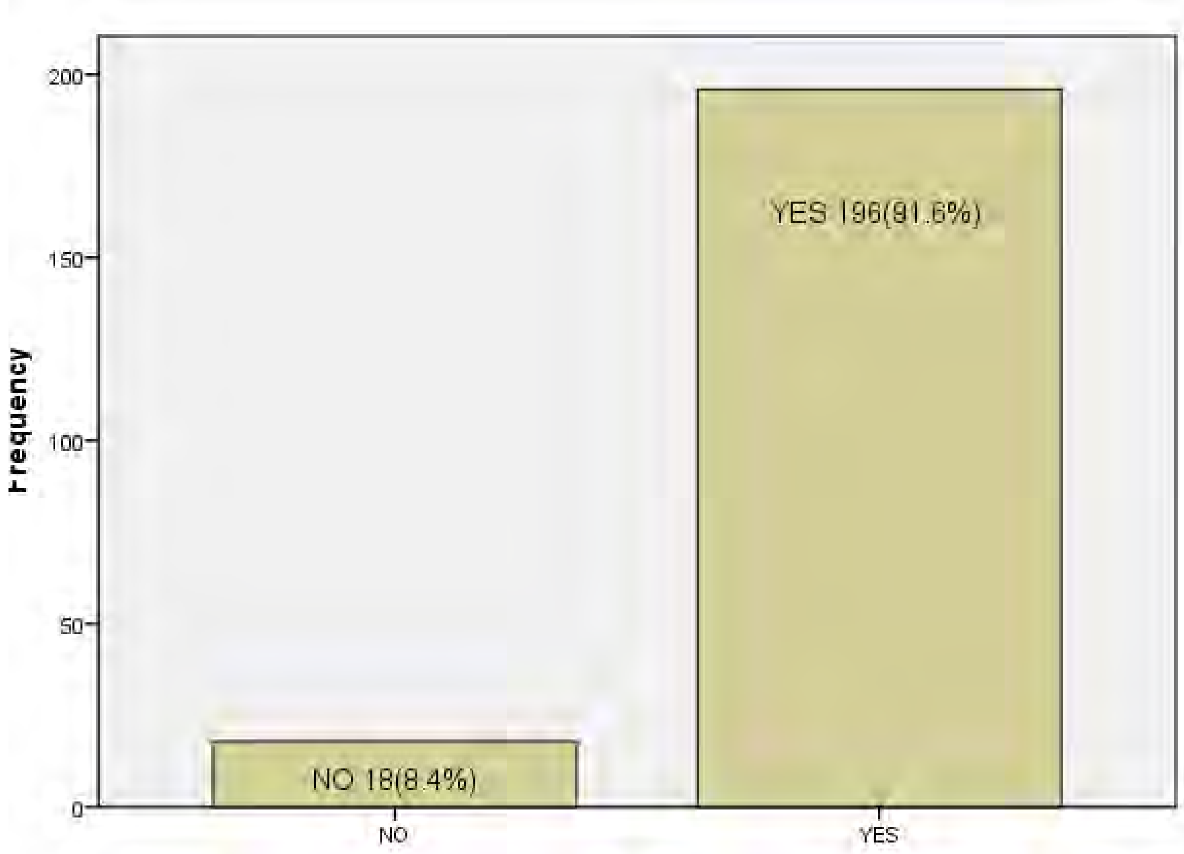

Figure 5.8 How work relationship helped in the flow and sharing of knowledge (N=214)

Figure 5.8 shows that 18(8.4%) of the respondents said the sound work relationship does not help in the flow and sharing of knowledge, while 196(91.6%) believed such a relationship helped the flow and sharing of knowledge in the five research institutes.

5.2.8.7 Extent to which work relationship helps sharing of knowledge

Respondents were asked to rank the extent to which a work relationship helped in the flow of information and sharing of knowledge in the institutes. The results are given in Table 5.30.

Table 5.30 Extent to which the work relationship helps in sharing of knowledge (N=214)

Extent to Which Work Relationships Helps in Sharing of Knowledge				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Very Low	0	0	0	0
Low	8	3.7	3.7	3.7
Indifferent	49	22.9	22.9	26.6
High	118	55.1	55.1	81.8
Very high	39	18.2	18.2	100.0
Total	214	100.0	100.0	

The results in Table 5.30 show the extent to which the work relationships helped in the flow and sharing of knowledge in the institutes. Eight (3.7%) respondents felt the impact was low, 49(22.9%) were indifferent, 118(55.1%) said the impact was high and 39(18.2%) believed the impact of a sound working relationship on knowledge sharing was very high.

5.2.8.8 Knowledge-friendly culture in the research institutes

Respondents were asked to rate the statements that describe the adoption of knowledge culture in the research institutes. The findings are shown in Table 5.31.

Table 5.31 Knowledge culture in the institutes

The Manner Things are Done Makes the Sharing of Your Experience and Knowledge Difficult (N=214)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Strongly disagree	60	28.0	28.0	28.0
Disagree	39	18.2	18.2	46.3
Neither agree nor disagree	37	17.3	17.3	63.6
Agree	58	27.1	27.1	90.7
Strongly agree	20	9.3	9.3	100.0
Total	214	100.0	100.0	
The Sharing of your Experience and Knowledge with Others is Enhanced by the way Things are Done in Your Institute (N=214)				
Strongly Disagree	0	0	0	0
Disagree	5	2.3	2.3	2.3
Neither agree nor disagree	20	9.3	9.3	11.7
Agree	116	54.2	54.2	65.9
Strongly agree	73	34.1	34.1	100.0
Total	214	100.0	100.0	
Communication in your Institute only Comes from the Top Management Down to the Subordinates (N=214)				
Strongly disagree	23	10.7	10.7	10.7
Disagree	41	19.2	19.2	29.9
Neither agree nor disagree	46	21.5	21.5	51.4
Agree	66	30.8	30.8	82.2
Strongly agree	38	17.8	17.8	100.0
Total	214	100.0	100.0	
Knowledge Creation, Codification and Transfer is Made Part of Institute's Culture (N=214)				
Strongly Disagree	0	0	0	0
Disagree	5	2.3	2.3	2.3
Neither agree nor disagree	30	14.0	14.0	16.4
Agree	113	52.8	52.8	69.2
Strongly agree	66	30.8	30.8	100.0
Total	214	100.0	100.0	
Research Results are Accessed Easily by the Stakeholders (N=214)				
Strongly disagree	3	1.4	1.4	1.4
Disagree	4	1.9	1.9	3.3
Neither agree nor disagree	44	20.6	20.6	23.8

Agree	102	47.7	47.7	71.5
Strongly agree	61	28.5	28.5	100.0
Total	214	100.0	100.0	
New Staff are Taught about the Job by Older/Experienced Staff in the Course of Performing their Duties: Mentoring (N=214)				
Strongly disagree	6	2.8	2.8	2.8
Disagree	14	6.5	6.5	9.3
Neither agree nor disagree	31	14.5	14.5	23.8
Agree	88	41.1	41.1	65.0
Strongly agree	75	35.0	35.0	100.0
Total	214	100.0	100.0	
Induction Courses are Organised for the New Staff in the Institute (N=214)				
Strongly disagree	6	2.8	2.8	2.8
Disagree	4	1.9	1.9	4.7
Neither agree nor disagree	48	22.4	22.4	27.1
Agree	86	40.2	40.2	67.3
Strongly agree	70	32.7	32.7	100.0
Total	214	100.0	100.0	

Table 5.31 indicates that the manner things are done makes the sharing of experience and knowledge with others difficult 60(28.0%) strongly disagreed, 39(18.2%) disagreed, 37(17.3%) neither agreed nor disagreed, 58(27.1%) agreed, while 20(9.3%) respondents strongly disagreed; the sharing of experience and knowledge with others is enhanced by the way things are done in the institutes 5(2.3%) disagreed, 20(9.3%) neither agreed nor disagreed, 116(54.2%) agreed, 73(34.1%) strongly agreed, while there was no response for strongly disagree; communication in the institutes only comes from the top management down to the subordinates 23(10.7%) strongly disagreed, 41(19.2%) disagreed, 46(21.5%) neither agreed nor disagreed, 66(30.8%) agreed, and 38(17.8%) strongly agreed; knowledge creation, codification and transfer is made part of the institutes' culture 5(2.3%) disagreed, 30(14.0%) neither agreed nor disagreed, 113(52.8%) agreed, 66(30.8%) strongly agreed, while there was no response for strongly disagree; research results are accessed easily by the stakeholders 3(1.4%) strongly disagreed, 4(1.9%) disagreed, 44(20.6%) neither agreed nor disagreed, 102(47.7%) agreed, and 61(28.5%) strongly agreed; new staff are taught about the job by older/experience staff in the course of performing their duties (mentoring) 6(2.8%) strongly disagreed, 14(6.5%) disagreed, 31(14.5%), 88(41.1%)

agreed, and 75(35.0%) strongly agreed; induction courses are organised for the new staff in the institutes 6(2.8%) strongly disagreed, 4(1.9%) disagreed, 48(22.4%) neither agreed nor disagreed, 86(40.2%) agreed, while 70(32.7%) strongly agreed.

5.2.8.9 Balance of flexibility and ease of accessibility to knowledge in the institutes

The respondents were asked to indicate how they access knowledge in their institutes. The results are shown in Table 5.32.

Table 5.32 Accessibility to knowledge in the institutes

By Word of Mouth (N=214)				
Responses	**Freq**	**%**	**Valid %**	**Cumulative %**
Never	12	5.6	5.6	5.6
Sometimes	46	21.5	21.5	27.1
Occasionally	66	30.8	30.8	57.9
Often	72	33.6	33.6	91.6
Very often	18	8.4	8.4	100.0
Total	214	100.0	100.0	
Communication through Letters (N=214)				
Never	1	0.5	0.5	0.5
Sometimes	3	1.4	1.4	1.9
Occasionally	25	11.7	11.7	13.6
Often	106	49.5	49.5	63.1
Very often	79	36.9	36.9	100.0
Total	214	100.0	100.0	
Memos (N=214)				
Never	5	2.3	2.3	2.3
Sometimes	34	15.9	15.9	18.2
Occasionally	57	26.6	26.6	44.9
Often	58	27.1	27.1	72.0
Very often	60	28.0	28.0	100.0
Total	214	100.0	100.0	
Minutes of Meetings (N=214)				
Never	3	1.4	1.4	1.4
Sometimes	31	14.5	14.5	15.9
Occasionally	66	30.8	30.8	46.7
Often	83	38.8	38.8	85.5
Very often	31	14.5	14.5	100.0

Total	214	100.0	100.0	
Emails (N=214)				
Never	56	26.2	26.2	26.2
Sometimes	53	24.8	24.8	50.9
Occasionally	39	18.2	18.2	69.2
Often	43	20.1	20.1	89.3
Very often	23	10.7	10.7	100.0
Total	214	100.0	100.0	
Gazettes and Government Publications (N=214)				
Never	56	26.2	26.2	26.2
Sometimes	35	16.4	16.4	42.5
Occasionally	64	29.9	29.9	72.4
Often	48	22.4	22.4	94.9
Very often	11	5.1	5.1	100.0
Total	214	100.0	100.0	
Speculations (N=211)				
Never	38	17.8	18.0	18.0
Sometimes	70	32.7	33.2	51.2
Occasionally	50	23.4	23.7	74.9
Often	42	19.6	19.9	94.8
Very often	11	5.1	5.2	100.0
Missing value	3	1.4		
Total	214	100.0	100.0	

The results in Table 5.32 show the way respondents' access knowledge and get to know about happenings in their institutes. By the word of mouth (verbal) 12(5.6%) said never, 46(21.5%) sometimes, 66(30.8%) occasionally, 72(33.6%) often and 18(8.4%) of the respondents claimed it was very often; communication through letters 1(.5%) responded never, 3(1.4%) said sometimes, 25(11.7%) occasionally, 106(49.5%) often, and 79(36.9%) believed it happens very often; memos 5(2.3%) had stated never, 34(15.9%) said sometimes, 57(26.6%) occasionally, 58(27.1%) often, while 60(28.0%) of the respondents claimed it was very often; minutes of meetings 3(1.4%) never, 31(14.5%) sometimes, 66(30.8%) occasionally, 83(38.8%) often, 31(14.5%) very often; e-mails 56(26.2%) said never, 53(24.8%) believed it happens sometimes, 39(18.2%) occasionally, 43(20.1%) often, and 23(10.7%) respondents said it happens very often; gazettes and government publications 56(26.2%) said never, 35(16.4%) said sometimes, 64(29.9%) said occasionally, 48(22.4%) often, while 11(5.1%) agreed it happens very often; speculations 38(17.8%) said it never happened, 70(32.7%) believed it to be sometimes, 50(23.4%) occasionally, 42(19.6%) often, 11(5.1%) claimed it happens very often, while 3(1.4%) respondents did not comment.

5.2.9 Challenges of knowledge management

The researcher sought to know from the respondents the challenges of KM activities in the institutes. The results are shown in Table 5.33.

Table 5.33 Challenges of knowledge management in the institutes (N=201)

Challenges	Responses							
	Available		Not Available		Missing Value		Total	
	Freq	%	F	%	f	%	f	%
Lack of Performance Indicators and Measurable Benefits	112	52.3	89	41.6	13	6.1	214	100.0
Inadequate Management Support	115	53.7	91	42.5	8	3.7	214	100.0
Improper Planning, Co-ordination and Evaluation	117	54.7	86	40.2	11	5.1	214	100.0
Inadequate Skills of Knowledge Managers and Workers	62	29.0	138	64.5	14	6.5	214	100.0
Problems with Organisational Culture	80	37.4	121	56.5	13	6.1	214	100.0
Loss of Knowledge from Staff Defection and Retirement	92	43.0	111	51.9	11	5.1	214	100.0
Lack of Synergy among Knowledge Management Crew	90	42.1	109	50.9	15	7.0	214	100.0

The results in Table 5.33 show the challenges faced by the five research institutes regarding knowledge management activities. Details of the findings are: lack of performance indicators and measurable benefits 112(52.3%) of respondents said there exist such challenges, 89(41.6%) did not agree such challenges existed; inadequate management support 115(53.7%) agreed, while 91(42.5%) of the respondents disagreed; improper planning, co-ordination and evaluation

117(54.7%) agreed and 86(40.2%) respondents disagreed; inadequate skills of knowledge managers and workers 62(29.0%) agreed, while 138(64.5%) disagreed; problems with organisational culture 80(37.4%) agreed and 121(56.5%) disagreed; loss of knowledge from staff turnover and retirement 92(43.0%) agreed, 111(51.9%) disagreed; lack of synergy among knowledge management crew 90(42.1%) disagreed, while 109(50.9%) agreed that the challenges were there.

5.3 Analysis of data from survey questionnaire using inferential statistics

In this section, cross-tabulation was carried out to ascertain the relationships and differences among the five research institutes in terms of level of knowledge production, knowledge management strategy used, generation of explicit knowledge and tacit knowledge.

5.3.1 Level of knowledge production

The researcher sought to compare the level of knowledge production among the five research institutes. The results are shown in Table 5.34.

Table 5.34 Comparison of rate of knowledge production in the institutes

Rate the Level of Knowledge Production Cross-tabulation						
Institutes		**Rate the Level of Knowledge Production**				**Total**
		Very Low	**Low**	**High**	**Very High**	
IAR ZARIA	Count	1	0	16	30	47
	Expected Count	0.9	2.0	26.4	17.8	47.0
	% within Institute	2.1%	0.0%	34.0%	63.8%	100.0%
IAR&T IBADAN	Count	1	3	29	9	42
	Expected Count	0.8	1.8	23.6	15.9	42.0
	% within Institute	2.4%	7.1%	69.0%	21.4%	100.0%
NRCRI UMUDIKE	Count	2	1	22	19	44
	Expected Count	0.8	1.9	24.7	16.7	44.0
	% within Institute	4.5%	2.3%	50.0%	43.2%	100.0%
NCRI BADEGGI	Count	0	3	25	13	41
	Expected Count	0.8	1.7	23.0	15.5	41.0
	% within Institute	0.0%	7.3%	61.0%	31.7%	100.0%
LCRI MAIDUGURI	Count	0	2	28	10	40
	Expected Count	0.7	1.7	22.4	15.1	40.0
	% within Institute	0.0%	5.0%	70.0%	25.0%	100.0%
Total	Count	4	9	120	81	214
	Expected Count	4.0	9.0	120.0	81.0	214.0
	% within Institute	1.9%	4.2%	56.1%	37.9%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.544[a]	12	0.005
Likelihood Ratio	31.147	12	0.002
Linear-by-Linear Association	4.968	1	0.026
N of Valid Cases	214		

The Chi-Square test shows that the P-value was (0.005) < 0.05, while the Chi-Square calculated value was (28.544), at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes with regard to knowledge production. It further shows that the probability of the difference not existing between the institutes is just 5% and this may be due to error, since all measurements (especially in social sciences) are not perfect, hence lack of control over chance factors. Therefore the researcher is obliged to give 5% chance factors to make provision for likely imperfections and demonstrate his/her readiness to take a risk at 5%.

5.3.2 Comparison of explicit and tacit knowledge generated

The researcher compared the generation of explicit knowledge versus tacit knowledge in the five research institutes. The results are shown in Tables 5.35 and 5.36.

Table 5.35 Comparison of explicit knowledge generation in the institutes

Comparison (Explicit Knowledge) Cross-tabulation						
Institutes		**Explicit Knowledge**				**Total**
		Very Low	**Low**	**High**	**Very High**	
IAR ZARIA	Count	2	2	20	20	44
	Expected Count	1.1	9.6	21.8	11.5	44.0
	% within Institute	4.5%	4.5%	45.5%	45.5%	100.0%
IAR&T IBADAN	Count	0	9	25	6	40
	Expected Count	1.0	8.7	19.8	10.5	40.0
	% within Institute	0.0%	22.5%	62.5%	15.0%	100.0%
NRCRI UMUDIKE	Count	1	10	20	11	42
	Expected Count	1.0	9.2	20.8	11.0	42.0
	% within Institute	2.4%	23.8%	47.6%	26.2%	100.0%
NCRI BADEGGI	Count	0	16	18	7	41
	Expected Count	1.0	9.0	20.3	10.7	41.0
	% within Institute	0.0%	39.0%	43.9%	17.1%	100.0%
LCRI MAIDUGURI	Count	2	8	19	10	39
	Expected Count	0.9	8.5	19.3	10.2	39.0
	% within Institute	5.1%	20.5%	48.7%	25.6%	100.0%
Total	Count	5	45	102	54	206
	Expected Count	5.0	45.0	102.0	54.0	206.0
	% within Institute	2.4%	21.8%	49.5%	26.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.883[a]	12	0.008
Likelihood Ratio	29.569	12	0.003
Linear-by-Linear Association	6.043	1	0.014
N of Valid Cases	206		

The above Chi-Square test shows that the P-value (0.008) < 0.05, and the Chi-Square calculated value was (26.883), at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes with regard to explicit knowledge generation.

Table 5.36 Comparison of tacit knowledge generation in the institutes

Comparison (Tacit Knowledge) Cross-tabulation						
Institutes		**Tacit Knowledge**				**Total**
		Very Low	**Low**	**High**	**Very High**	
IAR ZARIA	Count	2	2	23	16	43
	Expected Count	1.7	10.0	20.6	10.8	43.0
	% within Institute	4.7%	4.7%	53.5%	37.2%	100.0%
IAR&T IBADAN	Count	0	12	24	5	41
	Expected Count	1.6	9.5	19.6	10.3	41.0
	% within Institute	0.0%	29.3%	58.5%	12.2%	100.0%
NRCRI UMUDIKE	Count	3	11	17	12	43
	Expected Count	1.7	10.0	20.6	10.8	43.0
	% within Institute	7.0%	25.6%	39.5%	27.9%	100.0%
NCRI BADEGGI	Count	3	4	25	9	41
	Expected Count	1.6	9.5	19.6	10.3	41.0
	% within Institute	7.3%	9.8%	61.0%	22.0%	100.0%
LCRI MAIDUGURI	Count	0	19	10	10	39
	Expected Count	1.5	9.0	18.7	9.8	39.0
	% within Institute	0.0%	48.7%	25.6%	25.6%	100.0%
Total	Count	8	48	99	52	207
	Expected Count	8.0	48.0	99.0	52.0	207.0
	% within Institute	3.9%	23.2%	47.8%	25.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	39.701[a]	12	0.000
Likelihood Ratio	44.626	12	0.000
Linear-by-Linear Association	4.036	1	0.045
N of Valid Cases	207		

The above Chi-Square test shows that the P-value was (0.000) < 0.05, while the Chi-Square calculated value was (39.701), at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes with regard to tacit knowledge generation. The Chi-Square value also shows that the probability of the difference not happening among the institutes is just 5% and this may be due to error.

5.3.3 Comparison of the knowledge management strategy used by the institutes

The study sought to compare the knowledge management strategy most (system strategy and human strategy) used by the five research institutes to derive research and innovation. Table 5.37 shows the results for system strategy and Table 5.38 shows the results for human strategy.

Table 5.37 Comparison of system strategy used by the institutes

KM Strategy Mostly Used (System Strategy: ICT-Based) Cross-tabulation				
Institutes		**System Strategy: ICT-Based**		Total
		Not Available	**Available**	
IAR ZARIA	Count	20	27	47
	Expected Count	23.2	23.8	47.0
	% within Institute	42.6%	57.4%	100.0%
IAR&T IBADAN	Count	19	22	41
	Expected Count	20.2	20.8	41.0
	% within Institute	46.3%	53.7%	100.0%
NRCRI UMUDIKE	Count	15	27	42
	Expected Count	20.7	21.3	42.0
	% within Institute	35.7%	64.3%	100.0%
NCRI BADEGGI	Count	27	13	40
	Expected Count	19.7	20.3	40.0
	% within Institute	67.5%	32.5%	100.0%
LCRI MAIDUGURI	Count	22	17	39
	Expected Count	19.2	19.8	39.0
	% within Institute	56.4%	43.6%	100.0%
Total	Count	103	106	209
	Expected Count	103.0	106.0	209.0
	% within Institute	49.3%	50.7%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.191[a]	4	0.037
Likelihood Ratio	10.348	4	0.035
Linear-by-Linear Association	3.903	1	0.048
N of Valid Cases	209		

The above Chi-Square test shows that the P-value was (0.037)< 0.05, while the Chi-Square calculated value was (10.191), at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes in terms of the use of system strategy for knowledge management. The Chi-square value also shows that the probability of the difference not happening among the institutes is just 5% and this may be due to error.

Table 5.38 Comparison of human strategy used by the institutes

KM Strategy Mostly Used (Human Strategy: Social Network and Interaction) Cross tabulation				
Institutes		**Human Strategy: Social Network and Interaction**		**Total**
		Not Available	**Available**	
IAR ZARIA	Count	19	28	47
	Expected Count	12.2	34.8	47.0
	% within Institute	40.4%	59.6%	100.0%
IAR&T IBADAN	Count	7	33	40
	Expected Count	10.3	29.7	40.0
	% within Institute	17.5%	82.5%	100.0%
NRCRI UMUDIKE	Count	16	25	41
	Expected Count	10.6	30.4	41.0
	% within Institute	39.0%	61.0%	100.0%
NCRI BADEGGI	Count	0	38	38
	Expected Count	9.8	28.2	38.0
	% within Institute	0.0%	100.0%	100.0%
LCRI MAIDUGURI	Count	11	28	39
	Expected Count	10.1	28.9	39.0
	% within Institute	28.2%	71.8%	100.0%
Total	Count	53	152	205
	Expected Count	53.0	152.0	205.0
	% within Institute	25.9%	74.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.735[a]	4	0.000
Likelihood Ratio	32.557	4	0.000
Linear-by-Linear Association	4.156	1	0.041
N of Valid Cases	205		

The Chi-Square test shows that the P-value was (0.000)< 0.05, while the Chi-Square calculated value was (23.735) at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes in terms of the use of human strategy as a knowledge management strategy.

5.4 Presentation of data collected from semi-structured interviews

This section presents data collected from semi-structured interviews conducted with directors and heads of information and documentations of the five research institutes. As stated in Chapter Four of this study, a combination of qualitative and quantitative approaches was used for data collection. This is known as mixed methods. The aim of using both methods was to fully investigate, buttress and identify areas of convergence and divergence in the instruments. The results of the interview conducted with directors of the institutes are reported, in detail, in Appendix 18, while the results of interviews conducted with the institutes' heads of information and documentations are reported in Appendix 19.

The responses from the interviews are organised thematically. In addition to the findings that are based on specific research questions, the following issues were prominent. There was unanimity regarding the absence of KM policy in all the five research institutes, as confessed by the two categories of interviewees; 'knowledge' audit was a new term to the respondents; knowledge management strategy was basically human-based; institutes were grappling with dwindling budgetary allocation to support research and development and, by extension, to improve the KM activities; mentorship was the general mechanism for tacit knowledge transfer between older/experienced scientists and new scientists; workshops, seminars and conferences were the major ways for knowledge transfer, sharing, transmission and communication among research scientists, institutes and stakeholders.

5.5 Presentation of data collected from documents analysis

Document or content analysis is simply defined as the process of summarising and reporting written data, i.e. the main content of data and their messages. It is a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use (Krippendorp, 2004). Despite the absence of documents on KM policy, KM strategic plans and road maps, other documents have been analysed to derive issues such as the extent to which explicit knowledge is produced and managed by the institutes, areas of research priorities and instances of KM application such as products developed by the institutes. These documents include annual reports, in-house review meetings papers, operational guidelines, leaflets, units research reports and brochures.

The analysis of these documents revealed that the research institutes develop and conduct research on the following products/areas:

a. I.A.R. Zaria

1. Cereal Research

   Sorghum, maize, rice, millet, wheat, sugarcane

2. Legumes and Soil Seed

   Groundnuts, sesame, sunflower, cowpea, castor, soya beans, bambara nut, wing bean

3. Cotton Research

   Cotton, kenaf, roselle, jute

4. Artemisia Research
   Onion, pepper, local vegetables, ginger, tomato, citrus, mango, grapes, melon, pea
5. Biotechnology research
   Diagnostics, genomics, recombinants, marker assisted selection, micropropagation, Biosafety
6. Agric Mechanisation
   Machinery/technique evaluation, machinery/technique development, machinery management
7. Farming System

Surveys, on-station studies, on-farm studies, village-level studies

8. Irrigation Research

   Water resource development and management, irrigation cropping systems, environmental implication

9. Product Development Research

   Biological quality, local processing, industrial processing, monitoring of contaminants.

a. I.A.R. & T. Ibadan

1. Land and Water Resource Management Programme

   - Systemic mapping of major soils in south-western Nigeria

   - Rapid method of composing using Passively Aerated Composing Design (PACD)

   -Development of fortified organic fertilizer compost, organic manure, crop residues

   - Production of isoerodent map of south-western Nigeria, indicating potential areas of serious soil erosion.

2. Farming Systems Research

   - Improved nutrition status through consumption of soybean and utilization and internal rate of returns (IRR) was estimated
   - Co-ordinate the operation of adopted villages and schools as a window show of the display of the institute's intervention and agricultural development
   - On-farm evaluation trials and validation of research

3. Cereals Improvement Programme

   - Quality protein maize (QPM) has been evaluated for physical characteristics of grains

- Quality protein maize (QPM) has been selected for disease resistance and essential amino acids

- Quality protein maize (QPM) has been genetically characterised

- QPM varieties (ART-98-SW6-OB and ILE-OB) have been released and registered

4. Grain Legumes Improvement Programme

   - Cowpea varieties such as Ife-Brown, Ife BPC and Ife-98-12 were developed, released and registered

   - Germplasms of some under-utilised grain legumes such as African yam bean, Lima bean and pigeon pea were collected from south-west Nigeria, characterised and conserved

   - Technologies on the use of some botanicals (e.g. pawpaw extract) for the control of pests and diseases of cowpea have been developed. The technologies have been adopted by farmers

   - Some improved soybean varieties were developed in collaboration with I.I.T.A., which includes: TGM 344, TGX 306-036c, TGX 536-02D, TGX 713-02D, TGX 489-313D, TGX 1019-2Eb, TGX 1019-2EN, TGX 923-2E. Some of the varieties are well adapted to south-west agro-ecologies of Nigeria.

5. Post-Harvest Technology Improvement

   - Relative cheap and nutritious exotic snacks have been developed e.g. sausage, various biscuits and minced meat

   - Indigenous crops based beverages have been developed and disseminated to many farm families e.g. soya milk, soya corn

- Protein improved weaning food was developed, such as Propam and Powpena from maize, soybean, groundnut, crayfish and palm oil, as effective means of ensuring proper nutrition and combating kwashiorkor in children.

- Utilisation of underutilised legumes and kenaf was developed, such as the development of jam from roselle calyces and flavoured zobo drink from roselle.

6. Industrial Crop Improvement Programme

- High-yielding kenaf varieties through conventional breeding have been developed

- Techniques for production of internal decorator using Plaster of Paris (P.O.P.) and kenaf fibre have been developed

- Various textile materials like baskets, praying mats, shoelaces, ropes and twine from kenaf fibre have been produced.

6. Livestock Improvement Programme- production packages for cane-rat and snail, N'dama cattle, muturu cattle, rabbit have been developed to enable their multiplication in the country.

c. N.R.C.R.I. Umudike

1. Cassava Research Programme

- Evaluation of post-harvest physiological deterioration in high beta-carotene cassava genotypes

- Evaluation of selected high yellow root cassava varieties for total carotene content and agronomic parameters at Umudike

- Genetic improvement of cassava for root traits from manihot walkarae

2. Biotechnology Research Programme

- Identification of biochemical makers associated with response to bacterial blight disease in cassava

- Molecular quality control of transgenic cassava events produced by agrobacterium-mediated transformation

3. Minor Root Crops Research ProgramME

- Pest management strategies for the control of root-knot nematodes, *Meloidogyne spp*. Infestation of Livingstone potato *Plectranthus esculentus* and Hausa potato *Solesnostemonrotundifolius poir*.

3. Sweet Potato Research ProgramME

- Multilocational evaluation of introduced and locally bred sweet potato genotype

4. Yam Research Programme

- Developed multiple pests and disease resistance white yam genotype

- Dnvestigation on the use of yam slips for minituber production

5. Potato Research Programme

- Genetic evaluation of potato genotype for some agronomic traits, tuber processing traits and late blight resistance

- Diagnostic soil analysis of potato programme experimental field at Kuru and Heipang

6. Cocoyam Research Programme

- Cocoyam re-birth initiative

- Evaluation of youth and farmers participation on goken cocoyam rapid multiplication technology (GRMT) in Imo state

7. Ginger Research Programme

- Evaluation of advanced M4 mutant lines of ginger for selection

- Evaluation of effect of manure and palm bunch ash on yield of ginger *Zingiberofficinale* at Umudike

8. Farming System Research Programme

- Suitability evaluation of soils derived from coastal plain sand and shale for cassava/upland rice intercrops

- Determination of optimal level of dietary inclusion of soaked-and-boiled *Mucuna sloanei* in broiler starter feed

9. Extension Research Programme

- Analysis of gender and youth participation in adopted village project in Abia state

- Training of farmers on yam minisett technology in Benue and Kogi states

- Impact assessment of cassava-based technologies on the socio-economic status of farmers in Enugu state.

d. N.C.R.I. Badeggi

1. Rice Research Programme

- Observatory yield trial of upland rice varieties

- Evaluation of aratibiotech organic fertilizer effect on lowland rice production

- Evaluation of folia fertilizer/bio-stimulant for increase yields in lowland

2. Acha Research Programme

- Evaluation of 29 acha *D.exilis* accessions at Riyom, Plateau state

- Integrated management of acha brown leaf spot disease through the use of nitrogen fertilizer and the fungicide kitazine

3. Soybean Research Programme

- Soybean breeding activities

- Preliminary yield trial of early duration soybean genotype

- Evaluation of nutrient status of soils of soybean fields under continuous cultivation

4. Sugarcane Research Programme

- Sugarcane breeding and variety improvement

- Development of improved sugarcane through hybridisation

- Ealuation of exotic sugarcane germplasm for their breeding potential

5. Beniseed Research Programme

- Purifying NCRI BEN 01M, 03L and E8 via field assessment of their traits and attributes

- Observatory nursery/germplasm characterisation/maintenance pool

6. Castor Research Programme

- Castor germplasm evaluation

- Castor germplasm collection

- Determination of number of hoe weedings for optimal yield of castor.

e. L.C.R.I. Maiduguri

1. Seed Production Unit

- Millet varieties produced: LCICMV4 (PEO); SUPERSOSAT (LCICMV3); SOSAT-88 (LCICMV2) SUPERSOSAT (LCICMV3); LCIC9702; SOSAT-C88; EX-BORNO; SUPERSOSAT; LCICMV4

- Wheat varieties produced: ATILA; CETTIA; NORMAN; SERI M82;

2. Farming System Programme

- Evaluation of pearl millet germplasm (conservation and maintenance)

- Improvement of pearl millet cultivars for striga resistance in northern Nigeria

- Identification of sources of resistance to millet stemborer and head miner in pearl millet genotype

- Evaluation or vioyls liquid fertilizers and water soluble granular fertilizer on the yield of millet

- Evaluation of vioyls liquid fertilizers and water-soluble granular fertilizer on the yield of rainfed wheat

-Millet varietal maintenance and breeder seed production.

Analysis of the documentary sources revealed that the five Nigerian agricultural research institutes conduct research in all major categories of agricultural crops: food crops, such as cereals/grain, vegetables, fruit, oil, meat and spices; fibres such as cotton, wool; raw materials, plants and ornamental products such as drugs, biofuels, cut flowers and nursery plants. It further showed that other areas of research priorities include biotechnology, water resources development and management, environmental issues, agricultural mechanisation technologies, fertilizer and livestock production. The resultant effect of these research activities was the production and genetic improvement of varieties of products such as cotton, soybeans, cowpea, maize, pawpaw, millet, wheat, yam, potato, cassava, castor, sugarcane, acha, rice, cocoyam, ginger, groundnut, soymilk, onion, pepper, citrus, mango, grape and melon.

Finally, based on analysis of the documents and considering the areas of research priorities, the research and development activities in the institutes have the potential to contribute immensely toward knowledge production and dissemination and thereby stimulate the socio-economic development of Nigeria.

5.6 Triangulation of findings

The findings of the survey, as well as semi-structured interviews carried out to investigate the phenomenon of KM strategies and practices in Nigerian agricultural research institutes, was triangulated. The triangulation was put into a matrix table in order to depict some areas of convergence, to check for validity and reliability of the data set. The matrix is presented in Table 5.39.

Table 5.39 Matrix triangulation of findings across the instruments of data collection

Key Themes	Presentation of outcomes across instruments	
	Questionnaire	**Interviews**
Knowledge production and management in the institutes	High percentage of responses for knowledge production and management through interpersonal discussion with colleagues, workshops, seminars and conferences, research and consultancy, memos, reports and files, publications such as magazines, bulletins and newsletters, online and offline databases search. **(see P. 13)**	Knowledge is produced on a regular basis through research and results and documented on a regular basis through annual reports published by the institute and through journals published by scientists. Literature search from internet is satisfactory; conduct of research is intensive; Production of scientific publications is high. **(see Appendix 18 & 19)**
Knowledge management strategies used in the institutes	High response for the two types of knowledge management strategies mostly used by the institutes to derive research and innovations for increased productivity. Use of human strategy through interaction and social networks and system strategy via ICT facilities. **(see P. 22)**	Training and re-training of staff to improve their skills and share knowledge. Use of electronic library; use of interconnected networks; subscribing to local and foreign publications. (**see Appendix 18 & 19)**
Knowledge management strategic initiatives available in the institutes	High responses for KM initiatives such identification of existing knowledge, improved documentation of existing knowledge, improved co-operation and communication, improved training, education and networking of staff, improving access to sources of knowledge. **(see P. 21)**	Knowledge identification; knowledge creation; knowledge transfer; knowledge organisation, use of project teams; mentoring. **(see Appendix 18 & 19)**

Knowledge sharing among staff across departments/units	High responses for the sharing of knowledge between staff across department and cadres. Majority disclosed they share knowledge with all categories of staff through cross-functional project teams, cropping scheme meetings. **(see P. 15)**	Knowledge sharing is taking place through review meetings, cropping schemes meetings, seminars, workshops, conferences. Through interaction and journals; through station seminars; Newsletters, fact sheets and memos. **(see Appendix 18 & 19)**
Knowledge dissemination, transfer and communication	High responses for knowledge communication and transfer through research reports, newsletters and bulletins, personal contacts, e-mails. **(see Pp. 27-28)**	Linkage with Agricultural Development Partners (ADPs) – extension arm of the States Ministry of Agriculture; delivery of extension services; writing and presentation of research reports. Through training and workshops organised for stakeholders; through meetings with Agricultural Development Partners (ADPs) and other forms of collaborations. **(see Appendix 18 & 19)**
Mechanism for knowledge transfer/sharing between old scientists and newly employed scientists	High responses for mechanisms through which old/experience staff transfer and share knowledge with newly employed staff. New staff are taught about the Job by older/experienced staff in the course of performing their duties: Mentoring; induction courses are organised for the new staff in the institute. **(see P. 37)**	Organising conferences, workshops, seminars; presentations at the above fora; organising farm visits and demonstrations; formal and informal interaction with farmers and policy-makers. Publications, seminars, workshops and documentaries, meetings; crop schemes; workshops and seminars, and mentoring. **(see Appendix 18 & 19)**
KM best practices adopted by the institutes	High responses for the KM best practices adopted in the research institutes; community of practice and community of knowledge. **(see P. 19)**	Community of knowledge has been adopted and practised in the institute. Community of practice and community of knowledge. **(see Appendix 18 & 19)**

5.7 Summary of the findings

Chapter Five presented the analyses of data gathered through the survey, documents and semi-structured interviews carried out to investigate the phenomenon of KM strategies and practices in Nigerian agricultural research institutes.

The analysis involved the presentation of sampled researchers by institute, dept/unit/programme, gender, position/rank and educational status. The major variables analysed included the types of knowledge generated, extent of knowledge production, knowledge management strategies, knowledge dissemination and factors influencing knowledge management adoption in the five institutes.

Key findings from the survey show that KM activities exist in the institutes studied and the production of knowledge through research and development is enormous. The findings also revealed that knowledge dissemination was a commonly used term in seminars, workshops and conferences organised at regular intervals. Both system strategies based on ICTs (codification strategy) and human strategy based on interaction and social networks (personalisation strategy) were used to derive research, development and innovation in the institutes. Knowledge-sharing activities were considered a cardinal principle for research activities through review meetings, cropping scheme meetings, extension services, in-house training, farm visit strategy, informal interaction among research scientists and cross-functional project teams.

Findings from semi-structured interviews revealed that, despite the awareness, practice and acknowledgement of knowledge management as catalysts for improved productivity, there was an absence of a knowledge management policy and a lack of a periodic knowledge audit in all the five research institutes. The findings revealed that none of the five institutes had a dedicated KM department and position of knowledge manager. Both categories of interviewee decried the dwindling budgetary allocation as one of the stumbling blocks militating against the overall research activities and thereby hampering knowledge production.

Findings of the Chi-Square tests showed that there were significant differences between the five research institutes in terms of level of knowledge production, knowledge management strategy used, generation of explicit knowledge and tacit knowledge.

Finally, despite areas of convergence in the findings from both survey and semi-structured interviews (as encapsulated in Table 5.39), there are also areas of divergence in the findings. For example, while the interviews revealed that training opportunities are available, the majority of respondents from the survey revealed otherwise. Most of the respondents claimed to have attended such training once or twice in the past five years. In the final analysis, findings from both survey and semi-structured interviews were triangulated in a matrix table in readiness for discussion in the proceeding Chapter Six.

CHAPTER SIX

DISCUSSION OF FINDINGS

6.1 Introduction

This chapter presents the discussion and interpretation of findings obtained from qualitative and quantitative data collected and analysed in the study. The discussion and interpretation of results help to attach meaning to the results and explain what has been established by the researcher in the course of the study. They also provide a theoretical basis for further research (Kothari 2004). The theories that underpinned the research are infused in the discussion and interpretation of the results, as are the research questions and the research objectives. According to Leedy and Ormrod (2005), discussing and interpreting data means linking the findings to the original research problem, specific research objectives and questions, the literature and theories.

The main research objective of this study was to investigate the knowledge management strategies and practices in Nigerian agricultural research institutes. The following specific research objectives were addressed, to: identify the type of knowledge generated by the Nigerian agricultural research institutes; discover the extent of knowledge production by the research institutes; identify KM strategies used by the research institutes to derive research and innovation; determine how knowledge generated is disseminated; identify KM infrastructure available in the research institutes; and investigate factors influencing KM adoption in the research institutes.

The organisation of this chapter is based on the sequence of research questions (see section 1.9). The discussion is centred around the following research questions: What type of knowledge is generated by the Nigerian agricultural research institutes? What is the extent of knowledge production by the research institutes? What knowledge management strategies are used by the research institutes to drive research and innovation? How is the knowledge generated disseminated? What knowledge management infrastructure is available to the research institutes? What factors influence knowledge management adoption in the research institutes?

6.2 Demographic characteristics of the respondents

Demographic analysis was conducted to determine the department/unit/programme, educational status, gender, age, years of working experience and position/rank of the respondents in the research institutes.

The study revealed that the majority of the respondents were males 151 (70.6%), while females stood at 57 (26.6%), working in various departments/units/programmes of the institutes, as follows: 18(8.4%) were working in the Agric Econs and Extension Programme, 29(13.6%) in the farming system, while 26(12.1%) were working in the Biotechnology Department. The findings further revealed that 38(17.8%) of the respondents were working in the product development programme and 24(11.2%) were in the research outreach departments of the institutes, while the majority 79(36.9%) of the respondents were working in other departments/programmes, which include the cassava programme, yam programme, sweet potato, cocoyam, ginger, post-harvest, technology, maize, banana, kenaf and jute, cereals, trypanotolerant livestock, grain legumes, land and water resource management, cowpea, groundnut, cotton, confectioneries, castor and tomato programmes.

According to Alene *et al.* (2007) agricultural research is now principally carried out by 17 NARIs. Six of these deal with arable crops, three with forestry and tree crops, three with livestock, two with fisheries and one each with extension, processing and storage. Each has a national mandate for specific major commodities in each agro-ecological zone. IITA, in partnership with NARIs and other collaborative institutions, has developed and released, to Nigerian and other farmers in SSA, numerous improved varieties of cassava, yam, maize, cowpea, plantain and banana and soybean. Nigeria is now the world's largest producer of cassava, yam, and cowpea (Manyong *et al.,* 2005).

Further demographic data analysis showed that most of the respondents were in the age bracket of 29-49, with educational qualifications ranging from Master's degree 62(29.0%) and PhD 62(29.0%), at the rank of Research Officer I & II. Despite the availability of high calibre manpower, Nigeria's agricultural research faces the challenge of responding to the new demands to contribute to poverty reduction, in the face of declining national research budgets. In 2000, for instance, although Nigeria employed the highest total number of full-time equivalent researchers in SSA (11%), its share of spending was only 7% of the total US$1.5 billion (US$10.5 million)

(Beintema and Stads, 2004). The International Institute for Tropical Agriculture (IITA) has been supplying improved germplasm to NARIs and has strengthened their research capacity, mainly through collaborative research, short courses and long-term training of their staff at MSc and PhD levels.

6.3 Types of knowledge generated by the research institutes

The study sought to identify the types of knowledge generated by the Nigerian agricultural research institutes, by ascertaining the specific types of knowledge (tacit and explicit) generated, and the level of knowledge generation in the research institutes.

6.3.1 Knowledge generated by the research institutes

Based on the Nonaka and Takeuchi (1995) theory of knowledge creation, knowledge generation refers to the capability of an organisation as a whole to create new knowledge, disseminate it throughout the organisation, and embody it in products, services and systems. They stress that organisational knowledge creation is fundamental to the distinctive ways through which organisations create innovations. Knowledge creation and generation take place through continuous interactions between the epistemological and ontological dimensions of knowledge (Nonaka, 1994, Nonaka and Takeuchi, 1995), whether tacit or explicit (Nonaka and Konno, 1998; Nonaka and Takeuchi, 1995).

The findings of this study revealed that the research institutes generated knowledge in the following areas: genetic improvement of varieties of cereals, crops, roots, tubers, barley; wheat, rice, soybeans, sugarcane, beniseed, millet; crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation; crop improvement and management practices; generation of agricultural technologies and management practices; pest management, agronomic practices and improved seeds; fish production and management practices. These findings show that knowledge generation and creation in the five research institutes were within their core mandates of conducting research in major categories of agricultural crops, products, equipment and services such as: cereal research; grain legumes and soil seed; cotton research; biotechnology research; agric mechanization; farming systems; and product development research for agricultural development in the country. Joshi *et al.* (2001), in a similar study on the impact of Indian agricultural research found, that the Indian agricultural research institutes generated knowledge in the areas of: yield enhancement of sugarcane, hybrid rice, wheat and potato; pigeon pea, genetic enhancement of crops and tubers; resource management in agriculture; integrated pest management techniques; agricultural implements and versitol technology; social welfare and conservation of natural resources. The similarity in the results of the two studies (current study and that of Joshi *et al.*) may be attributed to the fact that both India and Nigeria are developing economies, hence the need to generate agricultural knowledge that could add value to their quest for food security. Revenue enhancement and overall development of the agricultural sector of the two nations is of paramount importance.

A study by Hahn *et al.* (2006) on knowledge generation and organisational innovation in wetland landscape on small, flexible municipal organisations in southern Sweden, identified the following knowledge that was generated: scientific and local knowledge on ecosystem and landscape management; adaptive governance; adaptive management; and resilience in social-ecological system techniques. Even though the locations of the organisations/institutes studied differ, the similarity in the findings of the present study and that of Hahn may be due to the fact that both organisations are focused on generating knowledge that could improve practices, products and services and, most importantly, meet up with their statutory responsibilities and obligations. Both studies used semi-structured interviews to collect data. Kaniki and Mphahlele (2002) posit that local knowledge emanate, from research conducted in areas unique to a given culture or society and is based on innovation and practical experimentation.

To sustain and improve the knowledge generation processes in knowledge-intensive organisations, Jing *et al.* (2009), in a study of knowledge creation in academia and research institutes at the Japan Advanced Institute of Science and Technology (JAIST), recommended that the following issues needed to be addressed: language barrier in discussing research questions with colleagues from other countries; making sharing tacit knowledge easier; developing a mechanism for critical feedback, in group discussions; training on how to organise and plan research activities; support in preparing presentations for seminars and conferences; support in designing and planning experiments; training on how to do experiments; guidance from one's supervisor and frequent communication within the group. The Resource-Based Theory (Barney, 1991; Peteraf, 1993; Amit and Schoemaker, 1993) focuses explicitly on the continuous creation of knowledge as the ultimate resource for the firm performance and attainment of competitive advantage.

Addom (2010), in a PhD study titled ‘Knowledge brokering in the digital age: the case of an agricultural innovation system’, sought to understand the phenomenon of knowledge creation and sharing within the agricultural innovation system of Ghana. In order to understand this complex phenomenon within an agricultural innovation system, interview and focus group discussion techniques were used to gather data from multiple sources. The results showed two sources of knowledge generation (local and scientific), such as: indigenous traditional irrigation practices, knowledge on weather forecasting, biological control of diseases and pests in soybean, production of new pesticide formulations and use of different plants and roots for soil fertility improvement. These findings are similar to results obtained from the semi-structured interviews about the types of knowledge generated in the research institutes in the current study, which showed that the knowledge generated was mostly scientific data, knowledge on agriculture; information on science and nature; findings from scientific investigations; results of experiments aimed at addressing the needs of farmers and other stakeholders; and technological packages for optimum productivity in agriculture.

6.3.2 Generation of explicit and tacit knowledge

Based on the Nonaka and Takeuchi (1995) model, there are two types of knowledge which include explicit knowledge and tacit knowledge. Explicit knowledge is knowledge that can be expressed in words and numbers and easily communicated and shared in the form of hard data, scientific formulae, codified procedures, or universal principles. The knowledge is synonymous with a computer code, a chemical formula, or a set of general rules normally found in documented form. Tacit knowledge has two dimensions. The first is the technical dimension, which encompasses the kind of informal and hard-to-pin-down skills or craft captured in the term ‘know-how’. The second is the cognitive dimension which consists of schemata, mental models, beliefs and perceptions. Though they cannot be articulated very easily, these implicit models shape the way we perceive the world around us. The knowledge category theory (Boisot, 1987) supports Nonaka’s model by classifying knowledge based on the ease of transmission and readiness to share. Boisot's (1987) theory regards knowledge as either codified or uncodified and as diffused or undiffused.

The findings of the present study revealed a high generation of explicit knowledge in the five research institutes. One hundred and two (47.7%) of the respondents viewed the generation as high, while 54(25.2%) thought it was very high. The perception for the high generation of explicit knowledge may largely be due to constant research and development activities, seminars, workshops and conferences taking place in the institutes and documentation of findings and knowledge generated in the form of research reports, seminar papers, manuals and other research guides and protocols. In a sharp contrast to the findings of the present study, Miguel *et al.* (2006) examined knowledge management issues in knowledge-intensive SMEs, in two knowledge-intensive SMEs in the South Yorkshire region, UK, using interpretive paradigm and interview as data collection instrument, found that owner/managers of SMEs did not perceive KM as a business critical function. While both small and medium companies collected and stored explicit knowledge in the form of training materials, newsletters, databases and company's websites, they did not seem to make active use of them as a source of knowledge.

The results of the Chi-Square test revealed that explicit knowledge generation in the five institutes was done with different intensity. The Chi-Square test for explicit knowledge generation showed that the P-value (0.008) < 0.05 and the Chi-Square calculated value was 26.883, at the 95% level of confidence. Based on the decision rule, there was significant difference between the five research institutes with regard to explicit knowledge generation. This finding may not be unconnected to the fact that explicit knowledge generation is enhanced by documentation research reports/results, seminars, workshops, meetings and conference papers, which are the statutory responsibility of the institutes.

Findings from the present study show that the generation of tacit knowledge by the five institutes was high, considering that 99(46.3%) of the researchers opined that it was high, while 52(24.3%) said the generation was very high. These findings conform to the principle of knowledge generation and creation in organisations by Nonaka and Takeuchi, which showed that organizations cannot create knowledge on their own without the initiative of the individuals and the interaction that takes place within a group. Knowledge can be amplified or crystalised at the group level through dialogue, discussion, experience sharing and observation. According to Nonaka (1991), knowledge sharing amongst employees contributes to the creation of new knowledge in the organisation, which is a critical activity that contributes to the success of the organisation, as new knowledge becomes available for everyone in the organisation to take advantage of. This may lead to innovative initiatives within the organisation, giving the company an advantage in the competitive world. This thinking is consistent with the Knowledge-Based View (Grant, 1996), which postulates that practices and routine interactions between and among employees produce tacit knowledge in organisations (e.g., Inkpen and Dinur, 1998; Lam, 2000; Malan and Kriger, 1998; Robertson and Swan, 1998).

Mudege (2005) established that agricultural knowledge was primarily social and its production was a social process; thus, gender dynamics, politics, power, conflicts, resistance, religious beliefs and government policies determined the production and socialisation of knowledge production in Zimbabwe. Shan *et al.* (2013), drawing from the Nonaka and Takeuchi (1995) knowledge creation theory, studied the impact of quality management practices on knowledge creation process in the Chinese aviation industry using a comprehensive literature review and field survey. The findings revealed that the use of cross-functional teams enabled employees to share ideas in light of their experience and promote the sharing of tacit knowledge. High generation of tacit knowledge by the institutes makes more sense to the Knowledge-Based Theory, because its central feature is the notion of 'tacitness' (Grant, 1996), as tacit knowledge is a potential source of competitive advantage due to its limited transferability.

Chi-Square tests revealed that the five institutes generated tacit knowledge at different proportions as shown by the detailed results in Table 5.36. Based on the tests, the P-value was (0.000) < 0.05, while the Chi-Square calculated value was (39.701), at the 95% level of confidence. Based on the decision rule, there was significant difference between the five research institutes with regard to tacit knowledge generation. Generally this finding is consistent with the findings of the current study in 6.7.1, 6.5.4, 6.5.1, 6.4.3, 6.3.6 regarding the dominance and large amount of tacit knowledge generated in the institutes. This result can be attributed to the availability of various avenues for knowledge-sharing in the research institutes, such as cropping scheme meetings, formal staff meetings, seminars, workshops and conferences used by the institutes to discuss research activities, share experience, practices, perspectives, challenges, opportunities and successes. Choi *et al.* (2006), drawing on the complementarity theory from economics, conducted a questionnaire-based survey to assess the KM strategies and organisational performance in 131 Korean firms. The results showed that combining the tacit-oriented and explicit-oriented KM strategies boosted knowledge production and enhanced the performance and competitive advantage of organisations. This finding corroborates that of the present study in which the research institutes were found to have been using tacit and explicit oriented methods to produce, manage and disseminate knowledge. The implication of this finding is that the research institutes have complementary and diversified methods of knowledge production, which recognised human and technology drivers.

Generally, the findings of the present study revealed that both explicit knowledge and tacit knowledge were generated in high proportion through research and development activities, seminars, workshops, conferences and sharing of experience, ideas and expertise, which became a norm in the institutes. To further elucidate the generation of the two types of knowledge in the institutes, findings from the semi-structured interviews revealed that both types of knowledge were generated by the institutes. Knowledge generated through regular interaction between scientists and management was documented. By and large, the two types of knowledge were found interwoven and complementary. In a related study, Herman (2013) used a knowledge-based view in a study titled 'Three shapes of organisational knowledge'. The study aimed at developing a typology of knowledge that could be fruitful in facilitating research in a knowledge-based production environment. The findings showed that differences between the tacit, codified and encapsulated shapes of knowledge carried strategic implications for the firm along six important dimensions, which included a locus or knowledge substrate, transferability, expression, acquisition process, source of economic value and observability. The findings revealed that different types of knowledge resources required different corporate strategies to maximise their value. Both the Herman and the present study recognise the importance of the two types of knowledge, which are pertinent in the organisations' quest for attaining competitive advantage.

6.4 Extent of knowledge production

In line with the Nonaka and Takeuchi (1995) theory, the study aimed at revealing the extent of knowledge production by the research institutes. This was achieved by investigating the modes of knowledge production, regularity and frequency of knowledge production, knowledge management activities performed and activities that led to knowledge production in the institutes.

6.4.1 Modes of knowledge production in the institutes

According to Bagshaw (2000), knowledge workers are valuable in organisations because they look for innovation which increases choices and thereby increase the organisations' knowledge asset. Findings of the present study revealed that knowledge in the research institutes was produced through: formal and informal interactions; mentoring; research, teaching and experiments; workshops, seminars and conferences; training and re-training; annual review meetings; adaptive research; cropping scheme meetings. The findings seemed to suggest that knowledge production was largely achieved through interaction, learning by doing and knowledge sharing in the five research institutes. The knowledge production process seemed to start with tacit knowledge and subsequently converted into explicit knowledge production. This confirmed the earlier findings about explicit knowledge and tacit knowledge generation, which was high in the five institutes, as shown in Table 5.10.

The findings are consistent with the Nonaka and Takeuchi epistemological dimension of knowledge production, in which knowledge creation starts when tacit and explicit knowledge interact with each other in what is referred to as epistemological dimension/knowledge conversion. Knowledge conversion is made up of four modes: socialisation (tacit to tacit), a process by which knowledge is synthesized; externalisation (tacit to explicit), a process where conceptual knowledge is created; combination (explicit to explicit), where systematic knowledge is created; and internalisation (explicit to tacit), where operational knowledge is created. All these modes of knowledge creation are not independent, but interact to create a knowledge spiral, which produces new products and innovations.

Ha *et al.* (2008), seeking to determine knowledge creation and dissemination in Sub-Saharan Africa, used a free broadband service Knowledge Centre in the Ihiala village of southern Nigeria.

The findings of the study revealed farmers used broadband technology, especially when it was available to them for free. The farmers evaluated positively the postings on the centre's web space. Ha *et al.* (2008) demonstrated the influence of interaction and social networking (both online and offline) on knowledge production, creation and dissemination. Yang *et al.* (2010), in a study of organisational knowledge-creation strategies, guided by knowledge-based theory and knowledge creation theory, proposed four modes of knowledge creation strategies, encapsulated in the EICE model - exploration, institutional entrepreneurship, combination and exploitation. The exploration strategy is concerned with converting new private personal knowledge through firm-specific unique knowledge to organisation-specific unique knowledge. It is a strategy through which an organisation increases its intellectual capital, by creating its unique private knowledge within its organisational boundaries (Ichijo, 2002).

The institutional entrepreneurship strategy is concerned with articulating private knowledge into public knowledge. The combination strategy is concerned with converting public knowledge (i.e. knowledge not unique to any one firm but also exists in the outside environment) into more complex and advanced sets of public knowledge. It focuses on the synthesis and application of current and acquired public knowledge (Kogut and Zander, 1992; Nahapiet and Ghoshal, 1998). The exploitation strategy focuses on transforming public knowledge into firm-specific private knowledge. It is also concerned with enhancing the intellectual capital of a firm with existing public knowledge (Ichijo, 2002). The variation in the findings of the two studies, with regard to the modes of knowledge production, may be as a result of the different approaches used in the two studies. While the present study used a mixed methods approach to obtain empirical data, the Yang *et al.* (2010) study was based on conceptual framework and literature review.

6.4.2 Regularity of knowledge production in the institutes

Knowledge production refers to new knowledge that is generated within an organisation which could be produced at job, individual, team, organisation or industry levels (Argote *et al.,* 2003).

Findings of the present study revealed that knowledge was produced regularly in the five research institutes. This was manifested in the responses in which the majority of the respondents 115(53.7%) believed that production was regular, while 80(37.7%) contended it was very regular, as presented in Table 5.11. These findings are not surprising given that the primary mandate and statutory responsibilities of the institutes is research, knowledge production and dissemination (Allee, 1997). In line with the Capability Perspective Theory (Teece *et al.,* 1997), R&D capability of organisations enables them to invent new technology, as well as to convert existing technology to develop new products and services. R&D capability helps a firm develop new technical knowledge and use this knowledge to design superior products and services (Teece *et al.,* 1997).

6.4.3 Frequency of knowledge production in the institutes

According to the Knowledge-Based Theory (Grant, 1996), continuous knowledge production in organisations is the only way to the successful attainment of competitive advantage. One hundred and ten (51.4%) respondents believed that knowledge production was frequent, while 96(44.9%) thought knowledge production was very frequent. These findings suggest that knowledge production was a common practice in the institutes.

Related to the findings of the present study, Zehrer (2011) studied KM in Australian tourism organisations, based on Grant's (2005) knowledge management model. The study found that knowledge production was frequent in the organisations through knowledge-sharing and the documentation of knowledge. The study made use of a four-point Likert Scale, ranging from 4=very frequent, 3=frequent, 2=rarely, and 1=never. In the study, a total of 73.5% respondents (n=36) very frequently make use of emails to store information and 18.4% (n=19) do not use this tool often. However, internal newsletters are used very frequently by 51% of the tourism organisations, whereas smaller organisations, with fewer than 25 employees, only rarely or never used internal newsletters. It was revealed that written protocols and documentation are used very frequently and frequently by 85.7% of the tourism organisations, while electronic discussion forums were rarely or never used by the majority of the respondents (81.6%). The convergence in the findings of the present study and that of Zehrer may be attributed to the fact that research institutes and tourism organisations are regarded as knowledge-intensive organisations (Knight and Harland, 2005; Hjalager, 2002). Also consistent with the findings of the present study was that of Assefa *et al.* (2011), who assessed the agricultural KM in dairy production improvement in the Amhara region of Ethiopia using semi-structured questionnaires and a literature review. The study found frequent knowledge production through experience sharing sessions, on-farm demonstration, learning by doing, listening to the radio and farm visits by officials of the Woreda Agricultural and Rural Development Office (WARDO).

Further analysis showed that there were significant differences among the five institutes in terms of level of knowledge production, as shown by the Chi-Square tests carried out by the researcher. The Chi-Square test showed that the P-value was (0.005) < 0.05, while the Chi-Square calculated value was (28.544) at the 95% level of confidence. Based on the decision rule, there was significant difference among the five research institutes with regard to knowledge production (see Table 5.34). This result may be attributed to the fact that the five institutes were established in different years, with different mandates, and they possessed varying calibres of manpower, facilities and resources to facilitate the development of agriculture in Nigeria.

6.4.4 Knowledge management activities performed by the institutes

The Nonaka and Takeuchi theory underlines the KM activities such as knowledge identification, acquisition, development, sharing, preservation and application of knowledge. Knowledge-Based Theory of Grant (1996) states that the first step to KM in an organisation is knowledge identification, which refers to the assessment of the competencies and knowledge assets of employees. The next step is knowledge measurement, which, according to Grant, means applying metrics to knowledge assets. Step three would then be knowledge storage and organisation, which he regards as the most critical step of KM activities. Steps four and five then are knowledge replication and sharing, respectively, which refer to the transfer of knowledge among employees (Malhotra, 2000).

In line with the KM theories of Nonaka and Takeuchi (1995) and Grant (1996), the present study sought to understand KM activities performed in the institutes. The findings revealed that all seven KM activities outlined above were performed. They included knowledge identification, as identified by 200(93.5%) of the respondents; knowledge acquisition 202(94.4%); knowledge creation 197(92.1%); knowledge organisation 180(84.1%); knowledge transfer 194(90.7%); knowledge application 203(94.9%); and knowledge adoption 203(94.9%) (see results in Table 5.13). These findings suggest that KM seemed recognised and institutionalised in the five institutes surveyed.

Nielsen (2006), in a literature review focusing on key knowledge management processes and activities, identified eight KM activities, some of which were similar to those practised by the research institutes that were surveyed. These activities include knowledge creation, acquisition, capture, assembly, sharing, integration, leverage and exploitation. Miguel *et al.* (2006) studied KM issues in knowledge-intensive SMEs of South Yorkshire, England, and found that the following activities were performed in SMEs: knowledge capturing; knowledge storage; knowledge sharing; and knowledge dissemination. The study revealed that performing these activities led to greater innovation and productivity in the SMEs. Bijaya and Uday (2011) examined KM processes in two learning organisations (Net Centre and Web Centre), using a qualitative method. Based on the findings, the knowledge management activities performed in the two organisations include: knowledge creation; knowledge sharing; knowledge up-gradation; and knowledge retention.

6.4.5 Activities of knowledge production in the institutes

Nonaka and Takeuchi's theory of knowledge creation asserts that knowledge production in organisations starts with knowledge sharing among employees and continuous research and development activities.

In line with the theory of Nonaka and Takeuchi, the present study investigated activities that generate knowledge production and sharing in the institutes. These activities included: interpersonal discussion with colleagues; workshops, seminars and conferences; research and consultancy; memos, reports and files; magazines and newsletters; online and offline databases. The findings show that all the activities are frequently performed in the five institutes. These findings corroborate the findings of the semi-structured interviews, where most of the respondents confirmed the performance of these activities that lead to the production and sharing of knowledge in their institutes. The researcher established that performance of such activities helped to generate the production of tacit and explicit knowledge in the various institutes and these findings corroborate the findings obtained through semi-structured interviews in which respondents claimed that knowledge was produced on a regular basis through knowledge sharing, research and development, annual reports and journal articles published by scientists. Related to these findings, a study of 431 US and European companies by Metaxiotis and Psarras

(2003) found that companies were engaged in new knowledge generation by accessing knowledge from outside sources (Singh, 2010).

6.4.6 Sharing ideas, expertise and experience for knowledge development

Nonaka and Takeuchi (1995) (Knowledge creation) and Teece *et al.* (1997) (Capability perspective theories) are unanimous concerning knowledge development through sharing of ideas, expertise and experience. According to Nonaka and Takeuchi, knowledge and expertise sharing is the bedrock for innovation and development in organisations, whereby figurative language such as metaphor and analogy are used to innovate and articulate the image of products. Teece *et al.* (1997) and Eisenhardt and Martin (2000) claim that knowledge capabilities, such as expertise, knowledge documents, lessons learned, policy, procedures and data, are shared for knowledge development.

Concurring with the Nonaka and Takeuchi (1995) and Teece *et al.* (1997) theories of knowledge management, the present study sought to know whether or not the researchers in the five institutes shared their ideas, expertise and experience in producing knowledge. The findings showed that almost all the respondents 210(98.1%) claimed to have been sharing their experiences, ideas and expertise with all categories of staff in the institutes. These findings suggest significant amount of knowledge production and sharing in the institutes, which is critical for driving competitiveness in a knowledge-based economy. In the knowledge-based economy, competitiveness is increasingly based upon access to knowledge in the form of skills and capabilities (Davenport and Bibby, 1999). The Framework Model asserts that cognitive functions, such as skills, experience, memory, comprehension and organisational learning, are key drivers of organisational competitive advantage (Steven, 2002). Steven adds that firms with a higher cognitive capacity are capable of outperforming firms with a lower cognitive capacity.

In spite of evidence showing that knowledge was shared across the organisations, Garfield (2006) outlines 10 reasons that may prevent people from sharing knowledge in organisations: people are unwilling to share knowledge when they do not know why they should share it; when they do not know how to do it; when they do not know what they are supposed to do; when they think the recommended way will not work; when they think their way is better; when they think something else is more important; when there is no positive consequence to them for doing it; when they are rewarded for not sharing and when they are punished for doing it.

6.5 Knowledge management strategies in the institutes

The present study sought to identify the KM strategies used by the research institutes to drive research and innovation. This objective was achieved by investigating the KM strategies used by the institutes. These include: system-based (codification strategy); and human-based (personalisation strategy). Other issues around the KM strategies aimed at enhancing the management of knowledge resources in the institutes were also investigated, such as KM best practices, KM resources and techniques, KM initiatives, skills for KM and specialists for KM systems available in the institutes.

Strategic initiatives are key to ensuring sustainable strategic competitive advantage for the organisation. (Despres and Hitrop, 1995; Neef, 1999; Davenport and Prusak, 1998; Day, 1994; Edvinsson and Sullivan, 1996; Davenport and Bibby, 1999). The choice of a knowledge strategy has been closely linked to the organisation's competitive positioning (Zack, 1999a). It is argued that an organisation's knowledge strategy should be considered a key component of its business strategy (Grant, 1996; Hansen *et al.,* 1999; Zack, 1999b; Earl, 2001). In addition, the organisation's knowledge strategy should provide direction in determining how information technology can enable and support knowledge work in the organisation (Davenport *et al.,* 2002; Dunford, 2000; Earl, 2001).

The findings of the present study show that human strategy (i.e. personalisation strategy) based on social networking and interaction was the dominant strategy used by the institutes for the management of their knowledge. The results revealed that the majority of the respondents 152(71.0%) had the view that the human strategy was used most often. The Chi-Square test revealed significant differences among the five institutes in terms of the use of human strategy (personalisation strategy) for the management of knowledge. The tests show that the P-value was (0.000) < 0.05, while the Chi-Square calculated value was (23.735), at the 95% level of confidence. Based on the decision rule, there is significant difference between the five research institutes in terms of use of human strategy as a KM strategy. Despite the relative high percentage in all the institutes (see Table 5.38), the researcher learnt that the differences with regard to the use of human strategy for knowledge management could be due to the differences that exist among the five institutes in terms of ICT adoption for KM. While the use of system strategies was higher in institutes such as Zaria, Ibadan and Umudike, Badeggi and Maiduguri institutes used more human strategy.

One hundred and six (49.5%) responded that system strategy (i.e. codification strategy) based on ICTs was used and 103(48.1%) said the system strategy was not available in their institutes. It was observed by the researcher that the situation of non-application of ICT-based services for KM could be attributed to the perennial infrastructural problem such as electricity, Internet service and other ICT facilities that characterized the Nigerian system. The rest said the system strategy was available, but it was learnt by the researcher that the facilities that were used were personal possessions of the respondents, due to the proliferation of the Global System for Mobile Communication (GSM) in Nigeria in the year 2001. Individuals use various applications such as social media and other or related systems of communication to share practices, experiences and know-how in the country.

Analysis of the findings from Chi-Square test revealed that there was significant difference among the five institutes regarding ICT adoption (codification strategy) for KM in the institutes. The test shows that the P-value was (0.037) < 0.05, while the Chi-Square calculated value was (10.191), at the 95% level of confidence. Based on the decision rule, there is significant difference among the five research institutes with regard to the use of system strategy/codification strategy for KM (see Table 5.37). The results show that Zaria, Ibadan and Umudike institutes used ICT facilities more for KM than Badeggi and Maiduguri institutes. This may be due to the fact that Zaria and Ibadan institutes are university-based research institutes (Ahmadu Bello University Zaria and Obafemi Awolowo University Ile-Ife), Umudike institute is located in the southern part of the country, where literacy level (Western education) is considered higher than in the northern part of the country. The low ICT adoption by Maiduguri and Badeggi institutes' could be due to their location (i.e. Borno and Niger States), which are considered Educationally Less Developed States (ELDS) in Nigeria (JAMB, 2000, cited in Asein and Lawal, 2007).

These findings support the Nonaka and Takeuchi theory of knowledge creation, which recommends the use of both human and technology for the management of explicit and tacit knowledge. However, much of the literature reviewed (Scarbrough *et al.,* 1999; Storey and Barnett, 2001; Alavi and Leidner, 2001; Bhatt, 2001; Newell *et al.,* 1999; Broendsted and Elkjaer, 2001; Huber, 2001) suggested that ICT could play a central role in the transfer of an organisation's knowledge. The fact is that ICT makes the transmission of explicit knowledge, which is in words, easier. Carbonara (2005) suggests that such mechanisms have the capability to transfer the vast array of knowledge and to reduce the space and time barriers. This is not supported by the empirical evidence of the present study, as the majority of the respondents claimed dominance of human strategy through active sharing for KM. This is also contrary to the resonating stance of Loeb *et al.* (1998), who observed that technology-assisted tools enable co-ordination across geography and time, and logically integrate data spreading all over the world.

A study by Jasimuddin (2008) on knowledge strategies in a UK-based group within a high-tech global corporation found the deficiency of a single KM strategy, because the findings revealed that the transfer of explicit knowledge is better with ICTs, while transfer of tacit knowledge is much effective via conversation, thereby suggesting a hybrid strategy which recognises the interplay between the soft and hard mechanisms. By hybrid, the respondents meant a combination of soft and hard approaches. The argument of Gupta and Govindaranjan (2000:489), for example, is very relevant:

> To be both effective and efficient, transmission mechanism must be tailored to the type of knowledge being transferred. When it comes to transmission mechanisms, 'effectiveness' refers to whether the receiver actually receives what the sender has sent; 'efficiency' refers to the cost and speed of the transmission channels. Document exchange is a highly effective and efficient mechanism for sharing codified knowledge. It is often highly ineffective, however, for transmitting tacit knowledge. Conversations and the transfer of people, by contrast, are relatively inefficient mechanisms for sharing codified knowledge. But, for transferring tacit knowledge, they may be the only effective mechanisms.

Hun Kim *et al.* (2014) conducted a study to test and validate the contingency model by analysing data collected through a survey conducted in Korea, using 141 firms to explain the effects of KM strategies on KM performance. The findings revealed three types of KM strategies by firms.

These include external codification (which means codifying organisational knowledge through formal information systems); internal codification (which means codifying organisational knowledge through formal information systems); and external personalisation (which refers to personalising knowledge through informal human networks).

A summary of the hypothesis testing showed that, when a firm's organisational IS maturity and environmental knowledge intensity are both high; the external codification strategy is the most effective way to improve that firm's KM performance. When a firm's organisational IS maturity is high and its environmental knowledge intensity is low, the internal codification strategy is the most effective way to improve that firm's KM performance. When a firm's organisational IS maturity is low and its environmental knowledge intensity is high, the external personalisation strategy is the most effective way to improve that firm's KM performance. When a firm's organisational IS maturity and environmental knowledge intensity are both low, the internal personalisation strategy is the most effective way to improve that firm's KM performance.

The findings of the present study are confirmed by the Hun Kim study, where both system or codification and human or personalisation strategies are used for the management of knowledge based on the situations and circumstances in organisations. Also, as a rider to the present study, Hou Hong *et al.* (2012), in a literature review based study set out to identify an effective KM strategy for Malaysian modern retail chains. The results suggest two different focuses: the codification strategy mainly concentrates on the content management system, while the personalisation strategy pays much attention to human interaction. The two strategies shared a common goal, which is fostering creativity and innovation within organizations. Scheepers *et al.* (2004) used a case study approach to examine the knowledge strategy and support of IT infrastructure in four knowledge-intensive organisations in Australia, which include ConsultCo, EduCo, ResearchCo and ManufactCo, to assess the model of knowledge strategy and IT support proposed by Hansen, Nohria and Tierney which recommended 80/20 (codification or personalisation) knowledge management strategy in organisations. Data was collected from multiple sources, including formal and informal interviews and documents and by inspection of systems.

The findings revealed that in ConsultCo there is dominant use of codification, little personalisation, extensive IT investment, mainly in support of codification strategy, and effective use of knowledge in codification and ineffective use in personalisation; in EduCo there is dominant use of personalisation, little codification, minimal IT investment, mainly in support of personalisation strategy and effective use of knowledge in personalisation and ineffective use in codification; for the ResearchCo there is dual emphasis on codification and personalisation, extensive IT investment in support of both codification and personalisation and effective use of knowledge in both codification and personalisation; while in ManufactCo there is no specific emphasis on either codification or personalisation, no specific alignment between IT investment and knowledge processes and ineffective use of knowledge in both codification and personalisation. It was also found that, in most of the cases, organisational resource constraints would in fact necessitate the choice of a dominant focus or strategy.

This result confirmed the findings of the present study concerning the use of both system or codification strategy and human or personalisation strategy in the institutes for the management of knowledge. This convergence may be attributed to the fact that the two studies used a similar approach (interviews and documents analysis) to collect data, and the perception that use of any strategy by organisations depends on the situation at which the organisation finds itself and the functionality or effectiveness of such a strategy. Related to this study, Choi and Lee (2002) propose a model to illustrate the link between the human and system strategies and its creating process. The model is derived on the basis of samples from 58 Korean firms and depicts how companies should align the strategies with Nonaka and Takeuchi's four knowledge creation modes such as socialisation, externalisation, combination and internalisation. It was found that human strategy is more likely to be effective for socialization, while system strategy is more likely to be effective for combination. The survey result suggests that managers should adjust knowledge management strategies based on the characteristics, need and peculiarities of their departments or organisations.

6.5.1 Knowledge management best practices at the institutes

Findings of the present study revealed that various knowledge-sharing best practices were in place. For example, community of practice (CoP), as attested to by 124(57.9%) respondents, was being used by the institutes to promote knowledge sharing. Community of practice is a forum where researchers working on a particular commodity/product engage in sharing of practices that lead to the actualisation, production and development of such a commodity or product. Community of practice consists largely of informal relationships between people who share common practices (Brown and Duguid, 2001, 1998; Lave and Wenger, 1991). Members of CoP typically spend time helping each other solve problems.

One hundred and sixteen (54.2%) respondents indicated that community of knowledge was one of the KM best practices in the institutes. Community of knowledge is a forum of knowledge workers drawn from various sections of the knowledge organisation for the purpose of knowledge exchange. A classic example is a cross-functional project team, where researchers from different sections, such as product development, marketing, product design, customer relations, form part of the process of developing a product or sharing practices based on their experience, from for example, trends in the market.

Martina *et al.* (2008) examined the relationship between business and the success of the KM initiatives, using 11 German and Swiss companies. The findings revealed that a relationship between the success of KM and the alignment of KM and business strategy existed. The study showed that an organisation whose business strategy required process efficiency should rely primarily on a codification strategy, which involves the use of ICT facilities in the generation, classification, sorting, storage and communication of knowledge such as document management systems, expert systems and groupware. In contrast, an organisation whose business strategy required product/process innovation should rely primarily on a personalisation strategy, which depends on human interaction through sharing of tacit knowledge via formal and informal meetings (Shan *et al.,* 2013; Yang *et al.,* 2010; Hun Kim *et al.,* 2014; Hou Hong *et al.,* 2012; Nonaka and Takeuchi, 1995). The study found that the most successful knowledge management projects were driven by a strong business need, with the goal of adding value to the organisational unit operations.

6.5.2 Knowledge management resources and techniques available in the institutes

According to the Resource-Based Theory (Conner and Prahalad, 1996), organisations use both tangible and intangible, internal and external resources to further generate and improve on their intellectual capital for the attainment of competitive advantage. Based on the Resource-Based

Theory, findings of the present study revealed that, out of the four KM resources and techniques (cross-functional project teams, mentoring, KM training and education, storytelling) (Frost, 2010; 2015), only two (cross-functional project teams and mentoring) were available in the institutes, as supported by 140(65.4%) respondents for cross-functional project teams, and 127(59.3%) respondents for mentoring, respectively. These findings are consistent with those outlined in 6.3.1, where mentoring was part of the modes of knowledge production, while KM training, education and storytelling were not practised in the institutes. Using cross-functional project teams ensures that knowledge work is performed through knowledge workers drawn from different departments/sections/programmes of the institutes, thus enabling sharing of practices and perspectives for better results. Mentoring serves as a strategic means of tacit knowledge transfer from old/experienced research scientists to newly employed research scientists in the institutes.

Coyte *et al.* (2012) examined processes used to control the management of knowledge resources in small and medium enterprises (SMEs) in the economic sector of Australia. Their findings revealed that informal, intensive dialogue and management philosophy, governed by strategy and the management of knowledge resources, were the underlying functional KM initiatives and strategies for the enterprises. An important discovery was the culture of teamwork across all employees and the open communication and accessibility to senior managers. This culture of teamwork indicates the practice of mentoring and cross-functional project teams, since it involves employees across levels and departments in the organisation. The results showed that value from knowledge resource management could not be fully realised, unless sufficient resources, such as internal and external contact networks, through which information is transferred and knowledge is shared, human capital, i.e. employees' knowledge, skills, expertise and abilities; organizational or structural capital, i.e. procedures, systems and other forms of codified knowledge that constitute how an organisation works; organisational culture, which is generally included in structural capital, were available to harvest that knowledge.

Alberts (2007), in a meta-analysis of case studies to determine the individual and team performance in the context of creating organisational knowledge, found that the works of cross-functional teams revolves around co-ordinating efforts, brainstorming, resolving conflicts and capturing and codifying organisational knowledge; member support; communicating with external stakeholders (e.g. sharing or transferring knowledge to the organisation's management, suppliers and customers); intellectual stimulation, introducing new ideas, recognition of achievements; friendly competition for increased motivation; developing new products; re-engineering processes; improving customer relations; and improving organisational performance through critical debates on various solutions. Similarly, Paiva *et al.* (2008), drawing from a resource-based perspective, used survey field data from 104 companies to understand how aspects related to cross-functional orientation, new technologies and increasing access to information-affected manufacturing strategy. The results indicated that cross-functional activities integrated manufacturing knowledge and contributed to the creation of valuable and rare product characteristics. They found that, through cross-functional teams, manufacturing was able to develop activities that were more highly integrated with other areas thus achieving or sustaining greater competitive advantages. Knowledge-Based Theory advocates for that cross-functional orientation and resulted in knowledge integration, which also led to a higher level of knowledge (Grant, 1996).

6.5.3 Knowledge management initiatives adopted by the institutes

Results revealed that the majority of the respondents were of the view that the KM initiatives were in place to derive research innovations. Such initiatives included identification of existing knowledge 190(88.8%), improved documentation of existing knowledge 203(94.9%); changing of the organisational culture 117(54.7%); improving co-operation and communication 186(86.9%); externalisation 136(63.6%); improving training, education and networking of newly recruited employees 193(90.2%); improving training and education of all employees 183(85.5%) improving retention of knowledge 175(92.1%); improving access to existing sources of knowledge 197(92.1%); and improving acquisition or purchasing of external knowledge 143(66.8%). The findings further showed that improving distribution of knowledge 184(86.0%), improving management of innovation 178(83.2%), and reduction of cost 110(51.4%) were available in the institutes.

Claudia and Marc (2010) studied KM approaches and strategies in the United Nations Development Program, the UN Economic Commission for Asia and the Pacific, the World Bank, the International Atomic Energy Agency, the OECD and the European Commission. Secondly they evaluated the progress of the respective approaches by using common test criteria such as introduction of KM in a staged approach or a ‘big bang’ strategy, special provisions for dealing with cultural aspects in knowledge sharing, the possibility to take over KM solutions from other organisations, and development of particular KM attributes typical for the organization. They found that all the institutions covered had passed the stage of information management (distributing information on the available methodologies and creating databases like the regional advisors mission report database (READ), providing an overview of important internal events to all staff members and putting active KM systems in place. Test criteria shows strong similarities in the KM implementation strategies chosen by the international organisations present. All bodies opted for a staged approach for the introduction of information and KM, rather than for a ‘big bang’ introduction of KM tools. The specific features of the KM systems in place depended very much on the organisational structure in place and the extent and possibilities of the ICT available.

All institutions covered in the study had passed the first phase of information and KM. An information sharing and management culture was established, via the creation of an information management system and human resources policies that favored an open information and knowledge sharing culture. The management of explicit knowledge - the second introductory phase of KM - was also in place to a larger or lesser extent in all institutions examined. All international organisations offered search and index tools and had created thematic knowledge networks internally and externally.

Two concepts emerged from the study of Claudia and Marc (2010), namely knowledge enablers which refer to knowledge creation in the form of self-learning, rewards for knowledge creation, induction training, decentralised and multi-channel knowledge-sharing, knowledge up-gradation by way of job rotation, external and internal benchmarking, a mandatory knowledge transfer process and multilevel knowledge retention controls and knowledge inhibitors (a top-driven knowledge sharing strategy), which restricts individual’s initiative, responsibility and accountability.

Bijaya and Uday (2011), in a study carried out on KM strategies in two information technology (IT) organisations in India, known as Net Centre and Web Centre, established four themes of KM strategies that included knowledge creation, knowledge sharing, knowledge up-gradation and knowledge retention. On knowledge creation, the findings showed that in Net Centre, knowledge centre happened mostly through both formal and informal ways. However, in Web Centre, knowledge creation took place in a formal and structured manner. In addition, in Net Centre, people were rewarded for idea generation. With regard to knowledge sharing, the commonality between Net Centre and Web Centre lay in their systematic organisational processes, such as meetings, issue chatting and video conferencing.

The study also found that there was a major difference between the two organisations, especially with regard to the extent to which people were involved. Net Centre, knowledge sharing strategies were top-driven, consistent with Riege (2005), who advocates for the 'use of strong hierarchy, position-based status, and formal power ('pull rank')'. The findings on the two organisations revealed that, in Net Centre, in-house training was quite intensive, compared to out-bound training. For knowledge retention the study found that there are proper knowledge retention mechanisms in both the organisations. In Web Centre, it was a 'one man responsibility', whereas in Net Centre, the knowledge retention process was not restricted to a single person. Ale *et al.* (2014) noted that knowledge sharing initiatives should take cognisance of organisational strategy; balance between social and technological KM aspects; change in the organizational culture; distributed KM; KM activities structuring; organisational knowledge identification (consciousness). The findings of Ale *et al.* corroborate the findings of the present study regarding the KM initiative used in the institutes such as identification of existing knowledge, changing organisational culture and improving distribution of knowledge. The similarity may be due to the dominance of such KM initiatives in the literature, where the present study generated most of its variables.

Kim *et al.* (2003), in a study on an integrative methodology for planning KM initiatives using literature reviews found that emphasis was placed on improving organisational performance by identifying and leveraging knowledge directly related to business processes and performance. The findings of Kim *et el.* are at variance with the findings of the current study a fact that may be explained by the fact that while the present study was empirical in design, that of Kim was largely based on literature review. Kim *et al.* (2003) acknowledged that their study, being exploratory, could not be generalised and would have limited empirical validity.

6.5.4 Skills for knowledge management in the institutes

The Nonaka and Takeuchi theory of knowledge creation describes the knowledge workers as those who use their heads more than their hands. Such workers give knowledge creation a sense of direction and set the standards for justifying the value of the knowledge that is being created.

The findings of the present study revealed that KM skills, such as processing factual and theoretical knowledge, finding and accessing knowledge, ability to apply knowledge, and knowledge integration and recombination are embedded in the organisation knowledge base. In a related study to assess the relationship between KM performance and knowledge management-based skills and competencies, Yang (2010), drawing on the theory of the resource-based view, examined the impact of KM strategy on strategic performance in Chinese High Technology firms, because they are knowledge-intensive firms which provide an appropriate setting for research on knowledge management. Data were collected using the CEO/general manager and senior manager as the key informants because of their knowledge of the firm, access to strategic information and familiarity with the environment of the firms, using 190 usable/returned questionnaires. The results from the moderated regression analysis showed that the KM performance was contingent on both performance-driven strategies (including reward system and process innovation) and knowledge management-based skills and competencies, such as R&D from past projects, market intelligence and intra-organisational knowledge sharing.

The findings of the Yang study are similar to the findings of the present study in the following ways: similar skills or competences are used such as R&D from past projects/findings and accessing knowledge, intra-organisational knowledge sharing/knowledge integration and recombination. One possible explanation for the similarity might be that both the Yang and present study are conducted in knowledge-intensive organisations. A competence-based theory (Sanchez, 2001b) postulates that firms utilise competencies in order to reach set goals, such as reduced costs or competitive advantage. A key feature of this theory is the transformation of knowledge into competencies, through learning cycles, encompassing individual, group and organisational learning (Sanchez, 2001b). Sanchez (2001b) suggests that the Nigerian institutes' skills serve as stepping stones for attaining greater performance and improved services delivery through transforming their knowledge into requisite competencies encompassing individuals and groups. Researchers and practitioners interested in the resource-based theory have used a variety of different terms to describe a firm's resources, including competencies (Prahalad and Hamel, 1990), skills (Grant, 1991), strategic assets (Amit and Schoemaker, 1993), assets (Rossetal, 1996) and stocks (Capron and Hulland, 1999).

6.5.5 Specialists for knowledge management in the institutes

The findings of the present study revealed that the following specialists were available for handling the KM systems: network administrators; database administrator; maintenance technician; data entry operator. These findings contradicted the earlier findings in 6.4.3, which indicate a low level of system strategy (codification strategy) in the institutes. However, some systems-based activities were observed in the institutes during data collection, such as e-records management, statistics generation, spreadsheet and word processing, use of Internet facilities, scanners and printers to communicate, explore, reproduce and share resources and practices.

6.6 Dissemination of knowledge in the institutes

Across the world, farmers and other stakeholders generally use conventional (older) ICTs (print, radio, television, video, fax) and modern ICTs (WorldSpace radio, computers, internet, web-based applications, cellular phone, CD-ROM), concurrently to access agricultural knowledge and technologies produced by universities and research institutes (Colle and Roman 2003; Wild 2006).

The present study sought to determine how knowledge generated was disseminated to the stakeholders and members of the institutes. This was achieved by investigating the availability and accessibility of knowledge, mode of transmitting knowledge to stakeholders, condition for access, utilisation of knowledge and source(s) through which the respondents acquired knowledge in the institutes.

6.6.1 Availability and accessibility of knowledge in the institutes

The present study revealed that all the sources of knowledge acquisition were available and accessible in the institutes. These sources are: experienced staff who have retired from service, as observed by 107(50.0%) of the respondents; experienced staff who are transferred around departments/units 134(62.6%); minutes of meetings 131(61.2%); research findings/results

168(78.5%); internal/external memos 108(50.5%); and official letters/file 99 (46.3%). The findings suggested that knowledge sharing and dissemination formed part of the culture of the institutes and this naturally facilitated creation of new knowledge and enhanced innovation and development.

The Nonaka and Takeuchi theory asserts that knowledge is created by individuals in organisations and, in turn, the organisations support creative individuals or provide contexts for them to create knowledge. The knowledge created by individuals becomes part of the knowledge network of the organisation. In the US Amayah (2013) examined the determinants of knowledge sharing in public sector organisations in the U.S. and, using quantitative research, established that enablers of knowledge access and dissemination included social interaction, rewards and organisational support. Wall (2006) found that power and culture determined creation, sharing and use of agricultural knowledge in rural Uzbekistan. Eze *et al.* (2013) used a survey study involving 680 manufacturing sector participants from SMEs in Malaysia, to determine the factors (trust, formalisation, knowledge technology, empowering leadership, effective reward systems and motivation) that influenced knowledge dissemination among the small and medium-sized enterprises (SMEs) in order to meet the challenges of today's dynamic business environment.

The findings of the Eze *et al.* (2013) study suggested that knowledge dissemination in SMEs was a challenging process that required a delicate balancing act between technological and social factors. Motivation, effective reward systems, trust and empowering leadership cultivated an effective knowledge access, sharing and dissemination culture in the SMEs. The findings revealed that knowledge technology was the most important determinant of knowledge dissemination among employees and stakeholders of SMEs. The findings of Eze *et al.* (2013) corroborate the findings of the present study regarding factors driving knowledge sharing and dissemination, such as trust, knowledge technology, motivation, effective reward systems and leadership. Similarly, PanHarry (1998), in an empirical study at Buckman Laboratories, found that knowledge dissemination was enhanced by availability and accessibility of knowledge. Knowledge dissemination was enhanced when easy and rapid access to knowledge bases was facilitated; when associates experienced the value of enterprise knowledge sharing in servicing customers; when time and space constraints in communication were eliminated; when respect and dignity of each individual was appreciated and when each individual was recognised as a valued member of a service-oriented team.

In contrast, Almeida and Soares (2014), in an ethnographic study of effectiveness of knowledge sharing and dissemination among project teams, found a shift in knowledge dissemination strategy using codification and personalisation mechanisms. Their findings revealed that knowledge was created in a dynamic way and spread around the organisation through creation, discovery, archive, retrieval, dissemination and re-use.

6.6.2 Modes of transmitting knowledge to stakeholders

Different communication channels have been used to communicate agricultural information and knowledge to farmers and other relevant stakeholders, including traditional channels (Mundy and Compton 1995; Karamagi Akiiki 2006); through study tours and exchange visits (Noordin *et al.,* 2001; Gianatti and Carmody 2007); and through ICTs (Richardson 1996; 1999; 2006; Alavi and Leidner 2001; Del Castello and Braun 2006), which have transformed the manner in which information and knowledge is shared.

The present study showed that newsletters and bulletins were the main medium for transmitting knowledge to the stakeholders in the five research institutes. The results showed that 122(57.0%) respondents were of the view that knowledge was transmitted through bulletins and newsletters, 46(21.5%) said it was transmitted through personal contact, 26(12.1%) said knowledge transmission occurred through email alerts and current awareness services, while 20(9.3%) were of the view that transmission of knowledge occurred through selective dissemination of information. These findings are presented in 6.4.3 and 6.4.5.

In contrast, findings of other studies around the globe (FAO and the World Bank 2000; Heeks, 2007; Karamagi Akiiki 2006) identified channels of communicating knowledge among stakeholders in agricultural sectors. For example, among channels that are being used to transmit knowledge are Farmer‘s Friend, an innovation of Google which uses point-of-presence (POP) established in rural areas of developing countries and the Grameen Village Program or Grameen Telecom’s Village Phone Program in Rural Bangladesh. The WorldSpace radio is also being used to deliver agricultural information and knowledge to disadvantaged rural communities.

With its headquarters in India it employs two satellites and broadcasts on 62 channels, 38 of which had content provided by international, national and regional third parties and 24 WorldSpace-branded stations produced by or for WorldSpace radio (Mchombu *et al.,* 2001; Munyua, 2007; CABI, 2014). The differences between results in this current study and those cited above may be attributed to different infrastructural facilities, including access to ICT, which, in Nigeria, is problematic and so institutes rely heavily on newsletters and bulletins. Okiy (2005) decried the problems of ICT use by the general public in Nigeria, because of inadequate telecommunication facilities, poor levels of computer literacy, poor levels of computer facilities, poor levels of awareness of Internet facilities among policy-makers and government officials, in general.

Agricultural knowledge dissemination can also be achieved through various channels, including private sector firms, extension agents, print and electronic media, universities, NGOs, agro-industries and suppliers of equipment and inputs (Berdegué and Escobar, 2001). For example, the FAO (2001) has developed the Farmer Information Network (FarmNet), piloted in Latin America and Africa, focusing specifically on farmers' groups. Another innovation is a prototype Virtual-Research Communication Network (VERCON) that provides data, information and knowledge on technical farming practices, weather, markets and events and has been piloted in Egypt. The VERCON is expected to be rolled out to other countries in Africa (FAO, 2003).

The findings of the semi-structured interviews in the current study revealed that knowledge transfer to stakeholders in the agricultural research sector occurred through memos, workshops, seminars, meetings, Agricultural Development Partners (ADPs) - the extension arm of the States Ministry of Agriculture - extension services and research reports. Kizilaslan (2006), in a case study of the agricultural information system in Turkey, with particular reference to its effectiveness for farmers' information and knowledge acquisition, found that there was insufficient connection between the publishing activities of research institutions and other institutions active in the field. This caused an incomplete distribution of agricultural information to farmers. The findings revealed that this created an information system in which there was no effective feedback in the 'research-publishing-farmer' triangle. The results also showed that technological advances and software packages developed with the hope of promoting efficiency in the information dissemination practices of research institutions and universities, or in the companies in developed countries, had not brought benefit to farmers.

The effectiveness of the public extension programmes had in reality diminished, because of limited budgets, lack of motivation and low morale among staff, a decreasing and inappropriately distributed number of extension attendants, the non-dynamic structure of the extension organisations and disconnections in communication among research institutions. The Kizilaslan study recommended the need for government to set up a unique institution specifically for the purpose of promoting extension, but also with the role of gathering centrally all the necessary information for extension work; to establish co-ordination among research institutions; to strengthen the connection between extension institutions and research institutions; to introduce appropriate technologies to farmers which are tailored to their needs, instead of those technological packages which are generally available on world markets; to set up new arrangements for extension programmes so that the farmer can actively participate in the creation of programmes, the planning and application stages of extension; to provide research and extension services that the farmers can shape to their needs; to grant opportunities to involve farmers' organisations in the information system, so that the farmers can enhance their productivity and improve their knowledge and abilities by first-hand participation; and to establish open communication forums with databanks, teletext, GSM systems, and all other relevant modern ICTs, to activate the information flow between the Ministry and research institutions and their information users.

The study by Kizilaslan depicts vividly the barriers for communicating agricultural information and knowledge in Turkey and recommended solutions which could also assist the Nigerian agricultural system to bridge the gaps that exist between the system and farmers in order to facilitate agricultural innovation dissemination. Ingram (2008), in a study of knowledge dissemination and exchange between agricultural advisors and farmers in the context of sustainable farming practice, in England, using semi-structured interviews with 31 agronomists and 17 farmers, found that, although many agronomist-farmers' knowledge dissemination and exchange encounters are characterised by an imbalance of power, distrust and divergence of knowledge, other encounters provide a platform for the facilitation of farmer learning, in their transactions to more sustainable practices and development of the farming system.

Mwidege and Mcharo (2014) conducted a study to determine the socio-economic factors affecting knowledge dissemination and technology transfer to maize growers in Kilindi District, Tanzania. The findings showed that age, household size, farm size and agricultural extension agents' contact had a significant influence on knowledge dissemination and technological transfer on maize growers in the study area. The study recommended that the local government should enforce equitable distribution of agricultural extension services in rural areas on how to use new technology to maximise yield and hence increase income. Gangadhar and Rupali (2011) assessed the role of information and communication technology (ICT) in the dissemination of knowledge in Indian agriculture. The study showed that, especially in the last 18 years, many ICT initiatives have been taken up under government, private and joint sectors, including satellite-based technologies like Integrated Potential Fishing Zones; customised mobile-based advisories via SMS; ICTs interventions like the Agricultural Marketing Information Network (AGMARKNET); e-learning; training extension officials and video conferencing.

The study recommended that the ICT initiatives should be user friendly, matching the farmers/stakeholders needs with appropriate modes of ICT as per local conditions; feasibility of ICT infrastructure at the cutting edge, i.e. high level, with utilisation and dissemination cost-benefit analysis; issues of bandwidth and legal framework need to be sorted out; and the provision of specific budget for promotion of ICT use by public R&D system. Chan and Costa (2005) conducted a study based on a literature review to determine the mode of disseminating research output in developing countries and found that the following medium were used for the dissemination of local research and to bridge the south-north knowledge gap: Health InterNetwork Access to Research Initiatives (HINARI, www.healthinternetwork.org/), which is developed and co-ordinated by the WHO; Global Online Research in Agriculture (AGORA, www.aginternetwork.org/), which is administered by the United Nations Food and Agriculture Organization; Electronic Information for Libraries. Net (elfl.net, www.elfl.net/), initiated by the Open Society Institute of the Soros Foundation; Program for the Enhancement of Research Information (PERI, www.inasp.info/peri/), co-ordinated by the International Network for the Availability of Scientific Publications (INASP); and other open access journal such as Scientific Electronic Library Online (SciElo, www.scielo.org); BIREME/LILACS, lilacs.bvsalud.org developed and indexed to journals from Latin America the and Caribbean; Bioline International (www.bioline.org.br), with publications from several African countries, as well as India, Brazil, Chile, Turkey and several other developing countries; and the Directory of Open Access Journals (DOAJ, www.doaj.org).

Khatam *et al.* (2013) carried out a study in seven districts in the central region of Khyber Pakhtunkhwa, Pakistan, to investigate the methods of disseminating agricultural knowledge and technologies to farmers. The results showed that the majority of the farmer respondents are aware of farm visits (66.43%), demonstrations being conducted (62.50%) and home visits made by the extension staff (60.71%), as methods for the dissemination of agricultural knowledge and technologies to the farming community as against methods such as office calls (31.78%) and telephone calls (22.85%).

Yu Lee *et al.* (2014) surveyed senior executives and high-ranking managers in Korea's top 52 chaebol firms, which had undertaken international diversification and another 1 068 foreign manufacturing subsidiaries to determine the patterns of innovative knowledge transfer strategies of globalized group-affiliated companies (GACs) from emerging markets. The study identified five distinct groups of innovative knowledge transfer patterns: small inactivator - with the smallest parent firm size and subsidiary size where GACs are inactive in sharing exploratory and exploitative technological knowledge, and subsidiaries manage their innovative knowledge autonomously at a very low level; hyperactive transferor - GACs and their subsidiaries in this cluster are very active in inter-GAC innovative knowledge transfer and in subsidiaries' innovative knowledge dependence on headquarters; *Laissez faire* exploiter, distinct from the other groups in that it reflects a managerial policy of allowing inter-GAC exploitative knowledge exchange somewhat more than inter-GACs exploratory knowledge exchange, but with the highest level of subsidiaries' innovative knowledge autonomy (i.e. minimal intervention for HQ-subsidiary innovative knowledge transfer); hands-on exchange avoider, distinct from the other groups in that such GACs focus solely on subsidiaries' innovative knowledge dependence on their HQs, with no interest in inter-GACs exploratory and exploitative innovative knowledge exchange; and moderate researcher, with moderate scores for all three innovative knowledge transfer dimensions and the highest for R&D intensity among all five groups. Yu Lee showed the pattern of knowledge transfer across levels which could help institutes-stakeholders knowledge transfer and sharing arrangement for agricultural innovation development in Nigeria.

6.6.3 Conditions for accessing and utilising knowledge by stakeholders

The present study revealed that conditions were not attached to accessing and utilising knowledge produced by the institutes. The majority of the respondents 153(71.5%) stated that there were no conditions for accessing and utilising information. However, 61(28.5%) said conditions were attached to accessing and using the knowledge of the institutes. The conditions included Memoranda of Understanding (MoU), registering before access, stating the reason(s) for access and utilisation, securing management approval and stating how the knowledge/information would be utilised. Nevertheless, the findings, on the whole, revealed that knowledge was easily accessed by the institutes' stakeholders. Easy access to knowledge generated enhanced its use and bridged knowledge gaps to promote sustainable agricultural development in Nigeria. Opondo *et al.* (2006) said farmers often make decisions, assess their performance, monitor and improve their activities. For these reasons, unhindered access by farmers to knowledge produced by the Nigerian agricultural research institutes, to improve their farming systems and increase their productivity, was vital.

Nidhraa *et al.* (2013), in a related study, used a systematic literature review (SLR) and interviews with industrial experts to investigate knowledge transfer in global software development (GSD) from two perspectives, state-of-the-art and state-of-the-practice. The purpose was to identify the challenges that hampered the success of knowledge transfer in global software teams, as well as to find out the mitigation strategies that could be used to overcome such challenges. The findings showed 60 different challenges and 79 unique mitigation strategies from both SLR and interview results. The challenges and mitigation strategies are grouped into three core categories of personnel, project and technology factors. Personnel factors included language barriers, cultural differences, trust, personal attributes and staffing. In contrast, project factors include infrastructure, requirement specifications, temporal distance, changing vendor, extra costs, project deadlines, novelty, community of practice and communication. Finally, technology factors included challenges with tool support and transactive memory system (TMS). The study recommended that effective management of project and personnel factors, facilitated by technological factors, were crucial for a successful transfer of knowledge in Global Software Development (GSD) projects.

6.6.4 Source(s) of knowledge acquisition by researchers of the institutes

The findings showed that the major source of knowledge for the respondents in the institutes was colleagues, as opposed to other sources, such as research reports and newsletters (see Table 5.24). The Nonaka and Takeuchi theory posits that knowledge that is accumulated from the outside should be shared widely within organisations and stored as part of the organisation's knowledge base.

A study by Kang and Kim (2013), involving 337 R&D employees to determine knowledge transfer patterns in South Korean organisations, found that facilitating social networks among employees was not enough to create active knowledge transfer. Instead, each employee needed to be guided to connect to the right experts, who had the correct knowledge (i.e. embedded resources) in his or her job. This view is consistent with the tenets of KM (i.e. learning by doing) and also the source of tacit knowledge in organisations. This finding also concurs with the results of the semi-structured interviews, in which the respondents were unanimous in their responses that knowledge sharing was taking place through review meetings, cropping schemes meetings, seminars, workshops, conferences, meetings and group/personal interactions.

Fong Boh (2007), in an empirical case study, conducted in two project-based organisations, Research Inc. and Consulting Inc., to examine the suitable configurations of knowledge-sharing mechanisms for organisations with different characteristics, found that the key mechanisms used for knowledge sharing in Research Inc. were individualised mechanisms that are predominantly oriented towards personalisation. Many interviewees reported that they used word-of-mouth to determine the right individual to approach for knowledge sharing. Many individuals depended on their personal network to find the answers to their questions, or to identify the right people to speak to. Research Inc. also used an individualised approach to sharing codified knowledge. When individuals and project teams re-used project documents from prior projects, such as proposals, budgets and project reports, such documents were usually found through personal networks and referrals. Institutionalised codification-oriented knowledge-sharing mechanisms were found to play a minor role in Research Inc. as the organisation was only in the beginning stages of establishing a database for staff resumes and project abstracts. In contrast, Consulting Inc. was large and employees often worked remotely as they could not depend on serendipitous encounters for knowledge-sharing to take place. They therefore institutionalised several mechanisms to expand the individuals' network beyond the immediate coworkers in regular and routine contact with the individual, and to provide easy access to experts, when required. To do this, the organisation deployed experts into positions where they could disseminate knowledge easily to others. Two of the most important codification-oriented mechanisms used by Consulting Inc. were the centralized database and the repository. The centralized database mainly served consultants who helped customers to implement and manage IT systems and resources (e.g. during systems development, implementation and support or managing customers' e-business strategy). The repository provided references of customer projects, as well as customer information to help consultants convince customers that the company had the necessary experience and expertise to provide satisfactory service to the client.

Both the present study and that of Fong Boh emphasised the importance of knowledge-sharing among employees as a panacea for innovation and development in organisations. The similarity in the findings of the two studies might be explained by the fact that both studies were conducted in knowledge-intensive organisations using similar approaches. Johansson *et al.* (2013), in a related qualitative case study, using 13 semi-structured interviews to determine the current status of Project Knowledge Management at Volvo Technology identified Communities of Practice as a way for Volvo Technology to further improve Project Knowledge Management, in support of knowledge-sharing between projects within the organisation. This personalisation strategy using CoP complemented the codification strategy. There is, however, a belief that transfer of knowledge by knowledge worker is mostly by personal interaction (Hanisch *et al.,* 2009).

A study by Al-Aama (2014) contradicted the findings of the present study, where employees at Jeddah Municipality Knowledge Centre revealed that they generated knowledge through online discussions, research, the internet, intranets, conferences, bulletin boards and workshops. Knowledge was also acquired by users through the Knowledge Centre digital library, online learning resources, projects and best practices. Furthermore, knowledge was captured by employees through video recordings of meetings, as well as organisational documents, the minutes of meeting and documentaries. Knowledge was also documented in IT policy manuals, standard operating procedures, work instructions, training materials, human resource and corporate communications, code of ethics, call centre scripts, safety regulations, product specifications, knowledge bases, quality manuals, technical documentation, business continuity and disaster recovery plans, compliance guidelines, employee handbooks, job descriptions, checklists and printable forms with usage instructions.

6.7 Knowledge management infrastructure in the institutes

The fifth objective of the study was to investigate KM infrastructure available in the research institutes by identifying the document management systems and knowledge management systems used. The Nonaka and Takeuchi theory of knowledge creation recognises knowledge management infrastructure to include people creating knowledge, knowledge culture and technology for knowledge preservation and transfer.

6.7.1 Document management systems available in the institutes

The current study revealed that the most viable document management system available in the institutes was archives, as opined by 160(74.8%) of the respondents. The study also revealed that the remaining two document management systems, which included group directories and other repositories such as CDs, were not available in most of the institutes because they are ICT-based, yet there is low adoption of ICT in Nigeria, as a whole, and the institutes, in particular (Okiy, 2005; and Alene *et al.,* 2007). The implication of this finding is that storage of knowledge resources in the institutes was manually done thus impacting on security, efficiency and access to knowledge. The current study confirmed (in 6.4.3) the low level of ICT-based systems in the institutes surveyed. Alene *et al.* (2007) observed that, in Nigeria, agricultural research has been at too low a level to significantly raise productivity and reduce poverty because, in part, the impact of new technologies has been less apparent.

Sanni *et al.* (2001) claimed that the Nigerian government had established a good number of research institutes, technology development centres and universities, to carry out the implementation of research and development objectives. However, infrastructural facilities required for research were grossly inadequate. As a consequence of this poor research environment in the country, many creative researchers had left for other places, where these facilities are available, and those trained abroad have refused to return to the country. Parallel to the potential of ICTs in the diffusion of agricultural knowledge and technologies are a number of challenges associated with the use and application of ICTs that have led to the urban–rural digital divide. Various authors (IIbuodo 2003; FOODNET 2007; Heeks 2007; Munyua 2007) point out a number of constraints, including inadequate local content, weak infrastructure and high licence fees.

Research indicates that effective information technology infrastructure is a crucial element in building and integrating firms' operations (Argyris and Schon, 1978; Duncan, 1972; Teece, 1998). According to Alavi and Leidner (2001), information technology, such as intranets and extranets, discussion forum boards, shared workspaces, Wikis, blogs and groupware, increases knowledge transfer by extending an individual's information access reach beyond formal lines of communication. Misra (2007) stressed that the four most popular types of knowledge management projects involve the implementation of intranets, data warehouses, decision-support tools and groupware. However, newer Web 2.0 technologies and electronic communication tools further enable employees and stakeholders to interact and to work together, regardless of their geographical location (Ruggles, 1998; Hislop, 2005). Despite the common use of manual systems for KM as a result of poor ICT infrastructure, Internet connectivity, and incessant electricity outage, among other factors, the research institutes surveyed have the potential to adopt sophisticated knowledge management infrastructure, as reflected by the results in Tables 5.5 and 5.8.

6.7.2 Knowledge management systems available

The findings of the present study showed the availability of the following knowledge management systems in the institutes: document management system, such as office systems, including word processing and desktop databases; organisational practice and routines, such as group collaboration systems, including discussion forums and work flows; training and knowledge intelligence, including community of knowledge, knowledge networks, knowledge culture, intelligent agents and rule-based personalisation. However, the Internet was not visible and used in most of the institutes. This implied that most of dominant KM systems were largely manual.

Other KM systems that were used on a low scale included: community of practice; personal networks; expert systems; informal networks; and groupware. This finding is related to that of Ale *et al.* (2014), in a study titled 'A conceptual model and technological support for organisational knowledge management'. The study found a KM system as highly social, rather than a technological artefact which consists of: knowledge distribution system such as practice and knowledge community; knowledge creation system such as socialisation, internalisation, externalisation and combination; and knowledge representation and retrieval such as domain worker and ontological engineer. The findings of Ale *et al.* (2014) are similar with that of the present study regarding the use of human-based (social), rather than technological, KM systems in the institutes. The possible explanation to this convergence in the findings of the two studies might be because many authors agree that KMS consists of infrastructures of both technological and social aspects, focusing more on sharing tacit knowledge between people by concentrating on creating knowledge and giving attention to social processes that can be supported by systems (Botha and Fouche, 2002; Alavi and Tiwana, 2002; Liao, 2003; Wong and Aspinwall, 2004; Abdullah *et al.,* 2005; Massa and Testa, 2009; Kruger and Johnson, 2010).

Okumus (2013), in a review of the literature on how hospitality organisations can facilitate KM through information technology (IT) tools by creating, storing, transferring and using tacit and explicit knowledge, found that hospitality organisations can use numerous IT tools in their KM, such as competency databases, decision-support systems, online search systems, expert networks, e-mail, groupware, teleconference, intranet, WWW, document management systems, video conferences, data warehousing and workflow software. The Okumus study also demonstrates that it is important to connect such IT applications with other non-IT applications and search for synergies among them and management practices to optimise these elements, so that tacit and explicit knowledge from different functional areas and management levels can be created, stored, transferred and used efficiently and effectively. To achieve this, hospitality organisations not only need to create a supportive organisational culture and structure, but also train and motivate their team members to manage knowledge through IT and non-IT applications.

Pandey and Dutta (2013) used in-depth, semi-structured interviews with key informants, as well as non-obtrusive participant observations, to examine the role of knowledge infrastructure capability in KM practices in a medium-sized, global Indian IT solutions company, known globally for its KM initiatives. This company featured in the Globally Most Admired Knowledge Enterprises (MAKE) list in 2010. The findings showed the relevance of knowledge infrastructure capability such as cultural capability, structural capability, technological capability and knowledge process capability in KM excellence. The findings revealed that organisational structure facilitates developing the culture of knowledge. This finding is consistent with the present study findings that recognise both technological and human systems as KM systems to foster and facilitate KM activities. These findings concur with Nonaka and Takeuchi theory regarding knowledge management infrastructure, which includes organisational culture, leadership, technology, knowledge networks and databases/repositories.

These findings are in stark contrast, however, with those of Coakes (2006), who assessed the impact of technology on knowledge sharing in transnational organisations. The results showed that technology could help to alleviate issues relating to space, time and virtuality, as well as provide the organisations with ways to share and distribute knowledge throughout their processes, sites and workforces. Another finding that contradicted the findings of the present study was that of Palvalin *et al.* (2013), who studied the impact of ICT services on knowledge in a medium-sized European teleoperator company. The findings showed that ICT could be used to eliminate non-value-adding tasks or to make them more efficient. ICT can also improve employee welfare, for example, through transforming the content of work by deleting unimportant activities. It further showed that ICT has the potential to transform knowledge work processes by decreasing waiting time and increasing efficiency. Both studies of Coakes (2006) and Palvalin *et al.* (2013) found positive impact of ICT in knowledge work transformation and facilitation in the two organizations studied. This transformation stride is not tenable in Nigerian agricultural research institutes, due to low ICT adoption, thereby negatively impacting on their performance and service delivery. While the studies by Coakes and Palvalin were based in developed countries where there is availability of sophisticated and hi-tech ICT facilities, the present study was based in Nigeria, where there is a digital-divide and application of ICTs in various sectors has not reached maturity. Nigeria's minister of communication technology, Mrs. Omobola Johnson, revealed that, in Nigeria's ICT industry, the delivery of content is still largely through traditional methods and not online. Moreover, Internet penetration was 22.1 per 100 people and 4.7 PCs per 100 people (Johnson, 2011). The International Telecommunication Union in its 2010 ICT development index report (ITU, IDI, Report 2010), noted that Nigeria's share of the global information superhighway is substantially lower, compared to advanced ICT countries (ITU, 2010).

6.8 Factors influencing knowledge management adoption

The sixth objective of this study was aimed at investigating the factors influencing KM adoption in the research institutes. According to Davenport *et al.* (1998) and Moffett *et al.* (2003), factors influencing KM adoption in organisations include: technology infrastructure; organisational infrastructure; balance of flexibility and ease of accessibility to knowledge; knowledge sharing; knowledge friendly culture; motivated workers who develop, share and use knowledge; means of knowledge transfer; senior management support and commitment; employee involvement and training; performance measurement, benchmarking and knowledge structure. Based on this, the study investigated: means of knowledge communication and transfer in the research institutes; knowledge sharing and knowledge sharing fora in the research institutes; knowledge friendly culture in the research institutes; and balance of flexibility and ease of accessibility to knowledge.

The Nonaka and Takeuchi theory of knowledge creation specified the factors that influence KM adoption as knowledge culture, knowledge infrastructure and knowledge sharing.

6.8.1 Channels of knowledge communication and transfer in the research institutes

Examination of findings from the current study revealed that major channels through which the respondents transfer and communicate their knowledge in the institutes was via formal staff meetings, as indicated by 96(44.9%) of the respondents. This is followed by sharing knowledge with colleagues and other relevant stakeholders, in whatever fora are available, both formal and informal, as indicated by 72(33.6%) respondents, while communication through memos was 23(10.7%) and informing the boss 23(10.7%) (see results in Figure 5.6).

These findings suggest that knowledge sharing took centre stage in the knowledge communication and transfer pattern of the institutes in conformity with knowledge creation and adoption of the Nonaka and Takeuchi theory. Mura *et al.* (2013) used six hypotheses from the literature, and tested them among 198 employees of four hospices and palliative care organisations (H&PCOs) for dying cancer patients, to study the relevance of engaging employees in knowledge-sharing behavior, in order to improve current operations. The results revealed a positive role of knowledge transfer and sharing behaviours in affecting sharers' innovativeness, in terms of propensity and capacity to promote and implement new ideas.

Sharing best practices and sharing mistakes were two distinct drivers of individuals' innovativeness.

Davenport and Prusak (1998) suggest that 'firms hire smart people and let them talk to one another and use water coolers, talk rooms, and picnics as examples of places where the transfer of tacit knowledge can take place'. In this regard, various methods are recommended as suitable for facilitating the transfer of tacit knowledge. Nonaka and Takeuchi (1995) use 'examples of apprenticeships, brainstorming camps, the use of metaphors and analogies, social network, and learning by doing as viable ways of tacit knowledge transfer'. Lam (2000) and Storey and Barnett (2001) suggest active direct communication between individuals as a means of transferring tacit knowledge. Such knowledge is typically shared socially through language and stories (Brown and Duguid, 1998), through the observation of practices that others undertake, or through a process of learning by doing within a communal context (Lave and Wenger, 1991). Reflecting on this view, Argote (1999) identifies several other mechanisms that exist for transferring knowledge, including training members, allowing them to observe the performance of other experts and providing opportunities for communication among organisational members.

6.8.2 Knowledge-sharing fora in the research institutes

The study found that all the 214 respondents answered in the affirmative with regard to knowledge-sharing activities through various fora such as conducting staff meetings, which was said to be crucial in facilitating knowledge-sharing in the research institutes. The respondents described staff meetings and other avenues such as informal meetings, cropping scheme meetings, review meetings, Internet news groups/social media, and other modes of collaborations, as major fora for knowledge sharing in the institutes. Bhatts (1998) stressed that a large part of knowledge is internalised within organisation through informal get-togethers and interactions among employees.

Further examination of the findings show that the conduct of staff meetings was usually done monthly, as revealed by 133(62.1%) respondents. This implied that there were frequent knowledge sharing platforms in the institutes. One of the important tasks for management is to facilitate the process of interactions among employees and to make them sensitive toward environmental stimuli, so that their individual knowledge is amplified and internalised, to contribute to the organisational knowledge base for increased innovation (Nonaka, 1994).

The findings revealed that the minutes of staff meetings are usually kept in the general office, where access is facilitated, as pointed out by 104(48.6%) of the respondents. This finding suggests that decisions, discussions and conversations during the meetings could easily be retrieved, thereby enhancing knowledge re-use in the institutes. According to the Nonaka and Takeuchi theory, knowledge should be leveraged, amplified and crystalised by organisations.

6.8.3 Knowledge -sharing culture in the research institutes

Analysis of the findings showed that a knowledge-sharing culture is entrenched, thereby stimulating the research and development drive of the research institutes. The knowledge-friendly, sharing culture of the institutes include: regular communication between the management and research scientists; knowledge creation and codification was made part of the institutes' culture; easy access to research results by the stakeholders; and mentorship of newly employed research scientists by the experienced scientists, thereby facilitating tacit knowledge transfer and innovativeness in the institutes.

These findings suggest that knowledge culture is adopted at all levels in the institutes' activities which, if sustained and encouraged, could transform the fortunes of the agricultural sector in the country. Mario and Fatima (2011), in a study carried out with a sample of 111 Spanish companies belonging to innovative industries, found evidence of a moderating effect of knowledge-centred culture on the relationship between knowledge exploration and exploitation practices and the innovation outcomes of companies. The results revealed the need for managers to pay attention to knowledge exploration, knowledge exploitation practices and organisational enablers, in order to achieve high levels of innovation for the company. Similarly, Daniel and Fernando (2006) in a study of 222 Spanish firms in the biotechnology and telecommunications industries, found how the firms that adopted KM culture obtained better results than their competitors.

The study by Daniel and Fernando concluded that a knowledge-sharing culture has a positive impact on the firm's performance. The Resource-based theory (Conner and Prahalad, 1996) asserts that the success and attainment of competitive advantage by organisations is determined by an entrenched knowledge-sharing culture through possession of, or access to, bundles of resources such as tangible resources (e.g. human resource/manpower facilities) and intangible resources (e.g. skills, expertise). This signifies the shift of focus of the resource-based theory from resources, *per se*, to the notion of organisational capabilities and routines inherently grounded in organisational knowledge (Nelson and Winter, 1982).

Both the present study and that of Mario and Daniel had similar findings (regarding the adoption of knowledge culture in organisations) to a study by Rajiv (2006), who used the resource-based theory in a PhD study at the University of Pennsylvania, entitled 'from common to uncommon knowledge: an investigation into socio-cognitive foundations of inter-firms heterogeneity in the use of knowledge as a resource'. The findings revealed that executive knowledge schemes significantly influenced the amount and nature of scanning behaviour that a focused executive engages in. Also, it shows that the nature of knowledgeable practice mediates the relationship between a firm's human, social and technological capital (i.e. its tangible knowledge assets) and its innovation capacity. Alavi and Leidner (1999), Barna (2002), Davenport *et al.* (1998), Chournazidis (2013) and Yu *et al.* (2004) suggested that knowledge-friendly organisational culture is a key driver of successful knowledge management implementations. Wong and Aspinwall (2005) identified and analysed eleven critical success factors when adopting KM which includes, management leadership and support, culture, information technology, strategy and purpose, measurement, organisational infrastructure, processes and activities, motivational aids, resources, training and education, human resources and management. Their studies stress that culture and support from management are the main issues for successful knowledge management adoption and implementation.

Akhavanand and Zahedi (2014), in a study to determine critical success factors for KM within project-based organisations (Start-Up Projects of Incubators in Sweden; Campaign for Real Ale (CAMRA), UK; Knowledge Sharing Communities in Finland; Project-Based Organisations in Finland; Project Members of GPM1 in Germany; Construction Industry in Taiwan) using the grounded theory approach identified, found the following: knowledge sharing, knowledge strategy, senior management support, IT applications, organisation knowledge-oriented culture, storing knowledge and knowledge structure. These findings are consistent with those of the present study, which revealed knowledge-sharing, knowledge-oriented culture and knowledge storage (explicit knowledge production) as responsible for high knowledge production in the institutes studied.

6.8.4 Accessibility to knowledge in the institutes

Research has shown significant association between organisational communication and many important outcomes. For example, organisational communication and easy access to knowledge is positively correlated with organisational commitment (Varona, 1996), job satisfaction and organisational climate satisfaction (Muchinsky, 1977; Mueller and Lee, 2002, cited in Abdullah and Antony, 2012).

An examination of findings from the current study shows that accessibility to knowledge was through: word-of-mouth; communication through letters; memoranda; and minutes of meetings. These findings suggest multiple sources for accessing both tacit knowledge and explicit knowledge in the institutes. However, other sources that are not actively used for communication and dissemination information to the members of the institutes include: emails; gazettes and government publications; and speculation. Related findings by Abdallah and Antony (2012), in a study titled: 'Perception of employees on internal communication of a leading Five Star Hotel in Malaysia using survey design' found that communication and ease of access to knowledge is a foundational effort of organisational success and employees of the hotel are proud of their bottom-up-top-down and horizontal communication that enhances employee-employer relations through face-to-face communication, memos, newsletters, press releases and bulletins. Narjes (2013), in a PhD study of communication practices in an organisation at Iowa State University, found communication via word-of-mouth and interaction with employees through Facebook as leading to significant increases in trust of an organisation by individual employees.

6.9 Challenges of knowledge management in the institutes

Analysis of KM challenges in the institutes revealed the following challenges: lack of performance indicators and measurable benefit; inadequate management support; and improper planning, co-ordination and evaluation. It was observed by the researcher that these challenges may be due to: perception of KM as a new and emerging concept in Nigeria; lack of political will to derive productivity and better performance in public sector organisations through human capital development in the country; poor attention paid to planning of activities by public sector organizations in developing countries such as Nigeria; and, more importantly, due to lack of KM policies that will provide directions, procedures and specifications/requirements/standards, in terms of manpower, equipment and legal apparatus for efficient management of knowledge in the research institutes. Modern science and technology policy deals with many functions, namely planning, budgeting, co-ordinating, administration and promotion of science and technology, and the effective implementation of activities in the area of research and scientific services (Sanni *et al.,* 2001). Other challenges included inadequate skills of knowledge managers and workers; problems with organisational culture; loss of knowledge from staff defection and retirement; and lack of synergy among knowledge management staff.

Studies by Davies (2005) and Chun-Ming *et al.* (2012) seem to provide more challenges affecting knowledge management. Davies, in an assessment of practices, bottlenecks and constraint of KM and knowledge sharing in a multinational company, revealed that information overload was a constant constraint, especially among the R&D personnel. Similarly Chun-Ming *et al.* (2012), in a study of factors affecting KM success in an aerospace manufacturing company in Taiwan, found that KM system capabilities and task characteristics improved KM performance. Added to these, findings by Chan and Chau (2008) imply that leadership and commitment of top management are two of the most important factors for successful KM implementation.

6.10 Summary of discussion of findings

Chapter Six discussed and interpreted the findings presented in Chapter Five. The interpretation and discussion of findings covered the main research questions and subsidiary questions and was done in accordance with the research problem, related literature reviewed, and principal and complementary theories underpinning the study, which included: Nonaka and Takeuchi (1995) Knowledge Creation Theory; Ginsberg (1994) Cognitive Framework Theory; Boisot (1987) Knowledge Category Theory; Teece *at al.* (1997) Capability Perspective Theory; Sanchez (2001b) Competence-Based View; Conner and Prahalad (1996) Resource-Based View; and Grant (1996) Knowledge-Based View. The interpretation and discussion attempted as much as possible, to show how the current study's findings support or differ from previous studies related to the present study.

The discussion showed that Nigerian agricultural research institutes are actively engaged in the generation of explicit knowledge and tacit knowledge, through their research and development activities. The study demonstrated that knowledge production was high, as evidenced in the modes of knowledge production, which included: formal and informal interactions; mentoring; research, teaching and experimentation; workshops, seminars and conferences; training and re-training; annual review meetings; adaptive research; and cropping scheme meetings. The findings showed the application and utilisation of the two KM best practices, community of practice and community of knowledge. Similarly, human strategy through interaction and social networks for knowledge management were the dominant strategies used by the institutes, compared with the system strategy, based on the application of ICTs. It was revealed that knowledge sharing was made part of the organisational culture in the five institutes, while access to knowledge produced was made easy for the stakeholders. Evidence of poor technological infrastructure for knowledge management was established in the five institutes, thereby impeding the efficiency, security and reliability of the knowledge production and dissemination activities.

CHAPTER SEVEN

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The main objective of the present study was to investigate the KM strategies and practices in Nigerian agricultural research institutes. The study sought to address the following specific objectives: identify the type of knowledge generated by the Nigerian agricultural research institutes; find out the extent of knowledge production by the research institutes; identify KM strategies used by the research institutes to derive research and innovation; determine how knowledge generated is disseminated; identify KM infrastructure available in the research institutes; and investigate factors influencing KM adoption in the research institutes.

The study was underpinned by a post-positivist paradigm and guided by the Nonaka and Takeuchi (1995) knowledge creation theory and six other complementary theories/models, such as; Boisot's (1987) knowledge category model, Grant's (1996) knowledge-based view, Conner and Prahalad (1996) resource-based view, Sanchez's (2001a) competence-based view, Ginsberg's (1994) cognitive-frameworks model, and Teece *et al.* (1997) capability perspective theory. Post-positivist paradigm enabled the use of qualitative and quantitative approaches, known as mixed methods (Creswell, 2003; Bryman, 2004 and Krauss 2005). The population of the study consisted of research scientists, directors and heads of information and documentation units in the five research institutes. Data was collected through survey questionnaires, semi-structured interviews and documentary analysis. Qualitative data were analysed using thematic analysis, as enunciated by Miles and Huberman (1994), while quantitative data were analysed using SPSS version 20.0 to generate descriptive and inferential statistics for actualising the objectives of the study.

The research questions of the study (section 1.9) are used as the organising framework for the chapter, under key headings of summary, summary of findings, conclusion, and recommendations. Chapter Seven presents the originality of the study, contributions of the study and suggested areas for future research.

7.2 Summary

Chapter One covers the context of the study, global perspectives of KM in agriculture, the historical development of the Nigerian agricultural research, development and mandates of the five study institutes, description of the study area, statement of the problem, objectives of the study, research questions and significance of the study. The purpose of the chapter was to provide the basis and foundation upon which the study was formulated.

Chapter Two (theoretical framework) introduces and outlines the principal and complementary theories/models underpinning the study. These include: Nonaka and Takeuchi's (1995) knowledge creation theory, Boisot's (1987) knowledge category model, Grant's (1996) knowledge-based theory, Conner and Prahalad's (1996) resource-based view, Sanchez's (2001b) competence-based view, Ginsberg's (1994) cognitive-frameworks theory, and the capability perspective theory of Teece *et al.* (1997). The chapter also provides the justifications for the appropriateness of the theories/models of this study.

In Chapter Three, related literature (empirical and descriptive) is presented, covering the research questions, key variables in the Nonaka and Takeuchi (1995) knowledge creation theory, and broader issues related to the research problem, such as knowledge production and generation in the agricultural sector; knowledge management strategies and agricultural research; knowledge dissemination in agricultural research; KM; the agricultural sector; agricultural research; knowledge workers and factors influencing KM adoption in agricultural research institutes. The key variables from the Nonaka and Takeuchi theory that are discussed include: explicit knowledge versus tacit knowledge; knowledge management infrastructure; and the knowledge spiral. On each theme discussed, the literature in an international context is reviewed first, followed by the regional and local contexts.

Chapter Four outlines the research methodology and methods. The chapter presents various paradigms focusing on post-positivist paradigm, which is pluralist, and consistent with survey design qualitative and quantitative approaches. Population of the study, sample size and sampling procedure, method of data collection, data processing and analysis, validity and reliability of the research instruments, and ethical considerations for the study, are also presented. The overall purpose of the chapter is to describe the step-by-step process (methodology) and then to actualise the objectives of the study.

Chapter Five covers data analysis and presentation of results from the three data collection instruments (survey questionnaire, semi-structured interviews and documentary analysis). The main objective of the chapter is to provide an overview of the data collected and how the raw data was transformed into meaningful facts through the use of certain methods of data presentation.

Chapter Six provides a discussion and interpretation of the research findings, using related extant empirical and theoretical literature. The chapter attaches meanings to the findings, in order to contribute to the domain body of knowledge on KM.

Chapter Seven provides the summary of the research findings, conclusion and recommendations. Originality of the study, contributions of the study from policy, practical and theoretical perspectives are adduced, and suggestions for further areas of research are outlined.

7.2.1 Summary of findings

This segment summarises the findings of the study. This summary is based on the sequence of research questions (section 1.9), reiterated here. What type of knowledge is generated by the Nigerian agricultural research institutes? What is the extent of knowledge production by the research institutes? What knowledge management strategies are used by the research institutes to drive research and innovation? How is the knowledge generated disseminated? What knowledge management infrastructure is available to the research institutes? What factors influence knowledge management adoption in the research institutes? In addition, findings on demographic information such as department/unit/programme, educational status, gender, age, years of working experience, and position/rank of the respondents are presented.

7.2.1.1 Summary of the demographic characteristics of the respondents

A demographic analysis was conducted to determine the department/unit/programme, educational status, gender, age, years of working experience and position/rank of the respondents in the research institutes.

The study revealed that the majority of the respondents were males 151 (70.6%), while females members 57 (26.6%), working in various departments/units/programmes of the institutes, as follows: 18(8.4%) were working in the Agric Econs and Extension Programme, 29(13.6%) in the farming system, while 26(12.1%) were working in Biotechnology department. Thirty eight (17.8%) of the respondents were working in the product development programme and 24(11.2%) were in the research outreach departments of the institutes, while 79(36.9%) of the respondents were working in other departments/programmes, which include the cassava programme, the yam programme, sweet potato, cocoyam, ginger, post-harvest, technology, maize, banana, kenaf and jute, cereals, trypanotolerant livestock, grain legumes, land and water resource management, cowpea, groundnut, cotton, confectioneries, castor and tomato programmes. Further demographic data analysis showed that most of the respondents were in the age bracket of 29-49 years, with educational qualifications ranging from Master's degrees 62(29.0%) and PhD degrees 62(29.0%) occupying the ranks of Research Officer I & II (see section 5.2.2).

7.2.1.2 Types of knowledge generated by in research institutes

The first research question of the study sought to investigate the types of knowledge generated in the five research institutes, using sub-questions such as knowledge generated by the research institutes, level of knowledge production and generation of explicit knowledge and tacit knowledge by the institutes. The findings showed that the research institutes generated knowledge in the following areas: genetic improvement of varieties of cereals, crops, roots, tubers and barley; wheat, rice, soybeans, sugarcane, beniseed, millet; crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation; crop improvement and management practices; generation of agricultural technologies and management practices; pest management, agronomic practices and improved seeds; fish production and management practices. The knowledge generated in the five research institutes was in accord with their core mandate and statutory responsibilities as agricultural research institutes especially with regard to conducting research on various crops in different ecological zones of Nigeria. This finding seemed consistent with Nonaka and Takeuchi's (1995) theory of knowledge creation, which asserts that knowledge generation involves creating new knowledge, disseminating it throughout the organisation, and embodying it in products, services and systems.

The study found that the level of knowledge production in the research institutes was high owing to the frequent workshops, seminars, conferences and research and development activities, which were held in such areas as cereal research; cotton research; biotechnology research; agricultural mechanisation; farming systems; and product development research for agricultural development. The study found that knowledge creation of an explicit and a tacit nature was high in the research institutes. Explicit knowledge generation was enhanced by the constant documentation of research findings, seminars, workshops and conferences. Tacit knowledge generation was facilitated by the knowledge-sharing culture entrenched in the research institutes through formal and informal engagements such as review meetings, cropping scheme meetings, community of practice, community of knowledge, knowledge networks and regular staff meetings.

7.2.1.3 Extent of knowledge production

The second research question of the study investigated the extent of knowledge production in the institutes. The findings showed that knowledge is produced through formal and informal interactions; mentoring; research, teaching and experiments; workshops, seminars and conferences; training and re-training; annual review meetings; adaptive research; and cropping scheme meetings. The study established that knowledge production was regular and frequent in the research institutes.

The study further revealed that KM activities associated with knowledge production, such as knowledge identification, knowledge acquisition, knowledge creation, knowledge organisation, knowledge transfer, knowledge application and knowledge adoption, were performed by the research institutes. These KM activities performed are in agreement with the theories of Nonaka and Takeuchi (1995) and Grant (1996). Nonaka and Takeuchi underline the KM activities such as knowledge identification, acquisition, development, sharing, preservation and application of knowledge. Grant's (1996) knowledge-based theory states that the KM in an organisation involves knowledge identification, knowledge storage and organisation and knowledge replication and sharing (Malhotra, 2000).

The study revealed that activities that lead to knowledge production in the institutes included: interpersonal discussion with colleagues; workshops, seminars, and conferences; research and consultancy, memos; publication of magazines and newsletters; online and offline database searches. The findings established that training seminars and workshops were organised for capacity building and improved knowledge production.

7.2.1.4 Knowledge management strategies adopted

The third research question of the present study investigated the KM strategies used to derive research and innovations in the research institutes, focusing on codification strategy (ICT-based); personalisation strategy (human-based); best practices; KM techniques; knowledge management initiatives; skills for KM and specialists for KM.

The study found that personalisation strategy (human-based), through interaction and social networking, was the dominant strategy used to derive research and innovations, followed by codification strategy (ICT-based). These findings are consistent with Nonaka and Takeuchi's theory of knowledge creation, which recommends the use of both human and technology for the management of explicit knowledge and tacit knowledge. The study established that community of practice and community of knowledge were the two knowledge management best practices adopted for the strategic management of knowledge resources in the five research institutes. The findings revealed that cross-functional project teams and mentoring were the two KM techniques for promoting KM.

The study found that km initiatives such as improved documentation of existing knowledge, changing organisational culture, improving co-operation and communication, externalisation, training, education and networking improving retention of knowledge, improving access to external knowledge and reduction of cost of service delivery, among others, were used to promote KM.

7.2.1.5 Dissemination of knowledge

The fourth research question of the present study sought to determine how knowledge generated and produced was accessed, shared and disseminated in the five research institutes.

The study found that knowledge was disseminated through staff who had retired from service, staff transfer from one department to another, minutes of meetings, research findings/results, internal/external memos and official letters/files. These findings showed a great deal of, and diverse sources of, knowledge dissemination of both a tacit and an explicit nature in the research institutes. Nonaka and Takeuchi (1995) advocate use of 'apprenticeships, brainstorming camps, the use of metaphors and analogies, social networks, and learning by doing as viable ways of tacit knowledge transfer'.

The study established that knowledge transmission and communication to stakeholders was largely via newsletters and bulletins, followed by personal contact with research scientists and extension agents, research reports, manuals and documents.

Despite the diverse ways of disseminating information in the research institutes, there was a belief that such dissemination was being hampered by conditions (such as need for MOUs, management approval, etc.) that were attached to accessing and utilisation of knowledge, especially by the stakeholders, which include: dissemination of knowledge; ensure that knowledge accumulated from the outside is shared widely within the organisation and stored as part of the organization's knowledge base. In addition, knowledge acquisition through research reports and newsletters signified the extent at which explicit knowledge is produced and utilised.

7.2.1.6 Knowledge management infrastructure

In the fifth research question, KM infrastructure available at the institutes was investigated. The findings revealed archives, group directories and institutional repositories. The archives were used to store non-current documents containing research reports, seminar papers, working papers, newsletters and related sources for future access and reference purposes. Nonaka and Takeuchi's theory of KM infrastructure asserts that both human and technology components such as organisational culture, leadership, technology, knowledge networks and databases/repositories are important KM infrastructure. Other KM infrastructure includes document management systems, such as office systems, including word processing and desktop databases; discussion forums; knowledge networks, intelligent agents, cross-functional project teams, mentoring, community of practice, and community of knowledge.

7.2.1.7 Factors influencing knowledge management adoption

The sixth research question investigated the factors influencing KM adoption in the research institutes, such as channels of knowledge communication and transfer; knowledge-sharing practices in the research institutes; knowledge sharing culture; and accessibility of knowledge.

The findings revealed that major channels through which the respondents transfer and communicate their knowledge in the institutes were staff meetings, colleagues and other relevant stakeholders in formal and informal gatherings, such as review meetings, cropping scheme meetings, cross-functional project teams, knowledge networks and group discussions. The study found that a knowledge-sharing culture was entrenched in the institutes through regular communication between the management and research scientists; knowledge codification; easy access to research results by the stakeholders; and mentorship programmes for newly employed research scientists. The findings revealed that accessibility to knowledge was through: word-of-mouth; communication through letters; memos; and minutes of meetings.

Davenport *et al.* (1998); and Moffett *et al.* (2003) outlined factors that influence KM adoption in organisations, to include technology infrastructure; organisational infrastructure; balance of flexibility and ease of accessibility to knowledge; knowledge-sharing; a knowledge friendly-culture; motivated workers who develop, share and use knowledge; availability of means of knowledge transfer; senior management support and commitment.

7.2.1.8 Challenges of knowledge management in the research institutes

The study established major challenges of KM in the five research institutes. These include: lack of performance indicators and measurable benefits; inadequate support from management; and improper planning, co-ordination and evaluation. This finding showed that the challenges were basically administrative, perhaps the belief that knowledge management is aimed at attaining organisational success and competitive advantage. The findings also showed that the lack of KM policy was a drawback for the five agricultural research institutes, as were the lackadaisical attitudes of staff.

7.3 Conclusions

The conclusions are based on the findings of each research question of the study, as follows: types of knowledge generated by the research institutes; extent of knowledge production in the research institutes; knowledge management strategies in the research institutes; dissemination of knowledge in the research institutes; KM infrastructure in the research institutes; and factors influencing KM adoption in the research institutes.

7.3.1 Types of knowledge generated

The research institutes studied generated knowledge in the following areas: genetic improvement of varieties of cereals, crops, roots, tubers and barley; wheat, rice, soybeans, sugarcane, beniseeds, millet; crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation; crop improvement and management practices; generation of agricultural technologies and management practices; pest management, agronomic practices and improved seeds; fish production and management practices.

From the findings it is surmised that the knowledge generated in the five research institutes is in line with their core mandate and statutory responsibilities as agricultural research institutes. These include conducting research on various crops in different ecological zones of Nigeria. The research institutes demonstrated capability for new knowledge creation, dissemination, embodiment of products, services and systems.

The level or knowledge production was high, as evidenced by frequent workshops, seminars, conferences and research and development activities. Knowledge production was enhanced by the constant documentation of research findings, seminars, workshops and conference papers. A culture of knowledge-sharing seemed entrenched in the organisation through formal and informal engagements, such as review meetings, cropping scheme meetings, community of practice, community of knowledge, knowledge networks and regular staff meetings. On the whole, explicit knowledge and tacit knowledge production and generation was high. This was achieved through seminars, workshops, conferences, review meetings, community of practice, cropping scheme meetings and regular staff meetings.

7.3.2 Extent of knowledge production

The findings point to high and frequent generation of both tacit and explicit knowledge through formal and informal interactions; mentoring; research, teaching and experiments; workshops, seminars and conferences; training and re-training; annual review meetings; adaptive research; and cropping scheme meetings. . The diverse activities of knowledge production in the research institutes have the potential to bridge the knowledge and innovation gaps in the Nigerian agricultural sector thereby rejuvenating food production capacity of the sector and redeeming its lost glory of the 1960s and 1970s.

The Nigerian agricultural research institutes are fully engaged in the KM chain of activities. This was having a positive influence on knowledge production, dissemination, preservation and utilisation in the country's agricultural sector.

Knowledge-sharing also seemed institutionalised across various cadres and levels of staff in the research institutes. This has the potential to enhance research and innovation in the agricultural sector in Nigeria.

7.3.3 Knowledge management strategies

The third research question investigated the KM strategies used to derive research and innovations in the research institutes. The institutions seemed to invest more in codification strategy (ICT-based); and personalisation strategy (human-based) as strategies for KM. There was also investment in community of knowledge practice, cross-functional project teams and mentoring, though to a lesser extent. The research institutes were influenced by the Nonaka and Takeuchi theory of knowledge creation, which advocates for both human and technology approaches in the management of explicit and tacit knowledge. The research institutes were influenced by the Nonaka and Takeuchi model because of its strengths to enhancing the organisation's competitive positioning (Zack, 1999a).

The adoption of personalisation and codification strategies for knowledge sharing in Nigerian research institutes can be leveraged to stimulate the standardisation of the KM practices in the institutes.

By using the strategies of KM (i.e. personalisation and codification) the research institutes seemed to be on the right path to repositioning themselves as knowledge production organisations in Nigeria's national economy. This could help bring transformation and revitalisation to the country's agricultural sector.

7.3.4 Dissemination of knowledge

The fourth research question sought to determine how knowledge generated and produced was accessed, shared and disseminated in the five research institutes, looking at modes of knowledge transmission and communication to stakeholders; and the conditions for accessing and utilising knowledge.

It was found that knowledge was disseminated through staff transfer or rotation in different department's minutes of meetings, research findings/results, internal/external memos and official letters/files. It was clear that methods of knowledge dissemination were diverse and consisted of both tacit and explicit approaches. There was a need to relax conditions of access to knowledge within the institutes, to promote its use that related to having MOUs, seeking authority from management of institutes and more. This free access and utilisation of knowledge is critical to research, development and innovation.

In spite of the restrictions on access to knowledge produced in the research institutions, scientists appeared to share knowledge freely with their colleagues, or through research reports and newsletters, cropping scheme meetings, review meetings, regular and formal staff meetings, community of practice, knowledge networks and interactions. The extensive use of personal exchange of information, conferences and workshops suggest extensive sharing of explicit and tacit knowledge in the research institutes.

7.3.5 Knowledge management infrastructure

The fifth research question concerned KM infrastructure available in the institutes. The research found the following infrastructures in place: document management systems; archives; group directories and other institutional repositories; organisational culture, leadership, technology, knowledge networks and databases/repositories; discussion forums; knowledge networks, intelligent agents; cross-functional project teams and community of knowledge. The results seemed to suggest that institutions relied on human and IT infrastructure for KM to derive maximum benefits and enhance collaborations and synergies between and among the knowledge workers.

7.3.6 Factors influencing knowledge management adoption

The sixth research question involved the factors influencing KM adoption in the research institutes. Davenport *et al.* (1998); and Moffett *et al.* (2003) outline such factors to include: technology infrastructure; organisational infrastructure; balance of flexibility and ease of accessibility to knowledge; knowledge sharing; knowledge friendly culture; motivated workers who develop, share and use knowledge; means of knowledge transfer; senior management support and commitment; employee involvement and training; performance measurement, benchmarking and knowledge structure.

The findings revealed that knowledge sharing was institutionalised in the research institutes, in part because of the entrenched culture of knowledge sharing. The policy framework and good working relationship among staff influenced the adoption of KM in the institutes.

The study found that a knowledge-sharing culture was entrenched in the institutes through: regular communication between the management and research scientists; knowledge codification, easy access to research results by the stakeholders; and mentorship programmes for newly employed research scientists.

The findings also revealed that accessibility to knowledge was through: word of mouth; and communication through letters, memos and minutes of meetings.

7.3.7 Challenges of knowledge management experienced

The present study found the major obstacles to KM in the five institutes to include lack of performance indicators and measurable benefits; inadequate support from management; and improper planning, co-ordination and evaluation. The KM policies are key instruments that can address the challenges outlined above. The research institutes by and large did not have KM policies and this may explain some of the listed obstacles. Such policies would define directions, procedures and specifications/requirements/standards, in terms of manpower, equipment and legal apparatus.

7.4 Recommendations

The study has discussed various factors influencing KM strategies and practices in Nigerian agricultural research institutes. The recommendations presented in the following sections are based on each of the research questions and their findings. The recommendations are made in the following areas: knowledge generation impact assessment, KM policy, KM infrastructure, capacity building, and knowledge dissemination.

7.4.1 Types of knowledge generated

The findings showed that the institutes generated knowledge in the following areas: genetic improvement of varieties of cereals, crops, roots, tubers and barley; wheat, rice, soybeans, sugarcane, beniseeds, millet; crop production, breeding, weed control, value-addition techniques, fertility of soil and mechanisation; crop improvement and management practices; generation of agricultural technologies and management practices; pest management, agronomic practices and improved seeds; fish production and management practices. Although the generation of explicit knowledge and tacit knowledge was high in the research institutes, it is recommended that there should be an agricultural research impact assessment by the institutes to ascertain the contribution of the knowledge generated to the revival of the dwindling fortunes of the agricultural sector in Nigeria. This is because during the 1950s, 1960s and early 1970s agriculture was the mainstay of the Nigerian economy and contributed to over 94% of government revenue and 60-70% of total exports (Daramola *et al.,* 2008). Since the discovery of oil Nigerian in the 1970s, agriculture's significance has declined and oil now totals 95% of exports and 40% of government revenue (EIA, 2012). Agriculture accounts for 0.2% of exports (Daramola *et al.,* 2008). This is supported by Joshi *et al.* (2001), who recommend that the impact of agricultural research is needed to empirically measure the research impact on social welfare and the conservation of natural resources.

7.4.2 Knowledge management strategies used

The study found that personalisation strategy (human-based) through interaction and social networking in a non-IT environment was the dominant strategy used to derive research and innovations, compared to codification strategies (ICT-based). The study therefore recommends a shift of focus to codification as a KM strategy so as to enhance the security, accessibility, efficiency, reliability and responsiveness of the knowledge management system for enhanced productivity and service delivery. The institutes' organization's knowledge strategies should be transformed to the use of information technology (Davenport *et al.,* 20002; Dunford, 2000; Earl, 2001). In this regard, Loeb *et al.* (1998) observe that technology-assisted tools enable co-ordination across geography and time, and logically integrate data spreading all over the world.

7.4.3 Dissemination of knowledge by the research institutes

The study established that knowledge transmission and communication was largely via newsletters and bulletins, followed by personal contact with research scientists and extension agents. The findings revealed that there existed some restrictions to free access to knowledge by the stakeholders, such as farmers, agricultural development partners, government at different levels, including federal, state and local government and non-governmental organisations. An enabling environment should be created through appropriate policies to facilitate access to knowledge generated in the research institutes. National agricultural research database/databank should be established to enhance awareness, documentation, access and utilisation of agricultural information and knowledge for overall national development.

7.4.4 Knowledge management infrastructure

The findings of the study established that there were several KM systems such as document management systems, including word processing and desktop databases; collaboration systems, discussion forums and knowledge networks. To strengthen the existing KM infrastructure, the present study recommends the establishment of a co-ordinated programme for the development of a National Information Infrastructure (NII), State Information Infrastructure (SII) and Local Information Infrastructure (LII), by using emerging technologies, such as satellites, including VSAT, fibre optic networks, high-speed gateways and broad-band/multimedia technologies to facilitate information and knowledge transfer among the research institutes and stakeholders/end-users. Alene *et al.* (2007) assert that effective information technology infrastructure is a crucial element in building and integrating firms' operations and providing linkages of information and knowledge in firms (Argyris and Schon, 1978; Duncan, 1972; Teece, 1998).

7.4.5 Challenges of knowledge management experienced

The study established that the major challenges of KM in the five institutes include: lack of performance indicators and measurable benefits; inadequate support from management; and improper planning, co-ordination and evaluation. This finding showed that the challenges were of an administrative nature. Chan and Chau (2008) assert that leadership and commitment of top management are two of the most important factors for successful KM implementation. It is therefore recommended that KM policy should be put in place to enhance the efficient management of knowledge by providing directions, procedures and specifications/requirements/standards, in terms of manpower, equipment and legal apparatus. Joshi *et al.* (2001), in a study of the impact of Indian agricultural research, recommended an appropriate policy environment, infrastructure and institutions as preconditions for the larger impact of agricultural research.

7.5 Contribution and originality of the study

Wassenaar (2006) cautioned that, for research to be of value, it should address issues that are important to a particular society or community within a society. The research questions addressed in the current study were of value to policy-makers, researchers, extension agents/workers, educators, ADPs and other governmental and non-governmental organisations in Nigeria as a whole, and more particularly to those who are dealing with the research institutes.

From a policy perspective, the findings have the potential to influence the formulation of KM policy in the Nigerian agricultural research institutes. The findings provide policy direction to planners, policy makers and information providers on KM development, reform and implementation in agricultural research, extension services, social networking, communication/access and ICT infrastructure, as recommended in sections 6.8, 7.4.2, 7.4.3, 7.4.4, 7.4.5. The findings also create awareness of KM in knowledge-intensive organisations, such as agricultural research institutes, for increased productivity and efficient service delivery.

For theory, the study contributes to the domain body of knowledge and literature, especially in the context of Nigeria. This study was the first comprehensive one of its kind to explore the KM practices in agricultural research institutes in Nigeria. The study also proposes a model for KM in agricultural research institutes, which builds upon the weaknesses of the Nonaka model, and other six models discussed in the thesis (see Chapter Two, Theoretical Framework). The weaknesses of extant KM models (see sections 2.9 and 3.12) include lack of focus on agricultural research systems; their general orientation and emphasis on private and business practices; and non-recognition of KM policy as a critical driver of a KM portfolio. The present study proposes a KM model for agricultural research systems/institutes, based on their peculiar responsibilities. The model also recognises KM policy, levels of knowledge production/generation, personalisation and codification strategies of KM knowledge and innovation diffusion platforms critical to the agricultural research system. Future research endeavours are invited to test the model. The model is illustrated in Figure 7.1 and its various components (knowledge generation process; KM strategies; knowledge domain; knowledge conversion; knowledge networks; knowledge and innovation diffusion; knowledge sharing; knowledge communities; KM policy) are discussed.

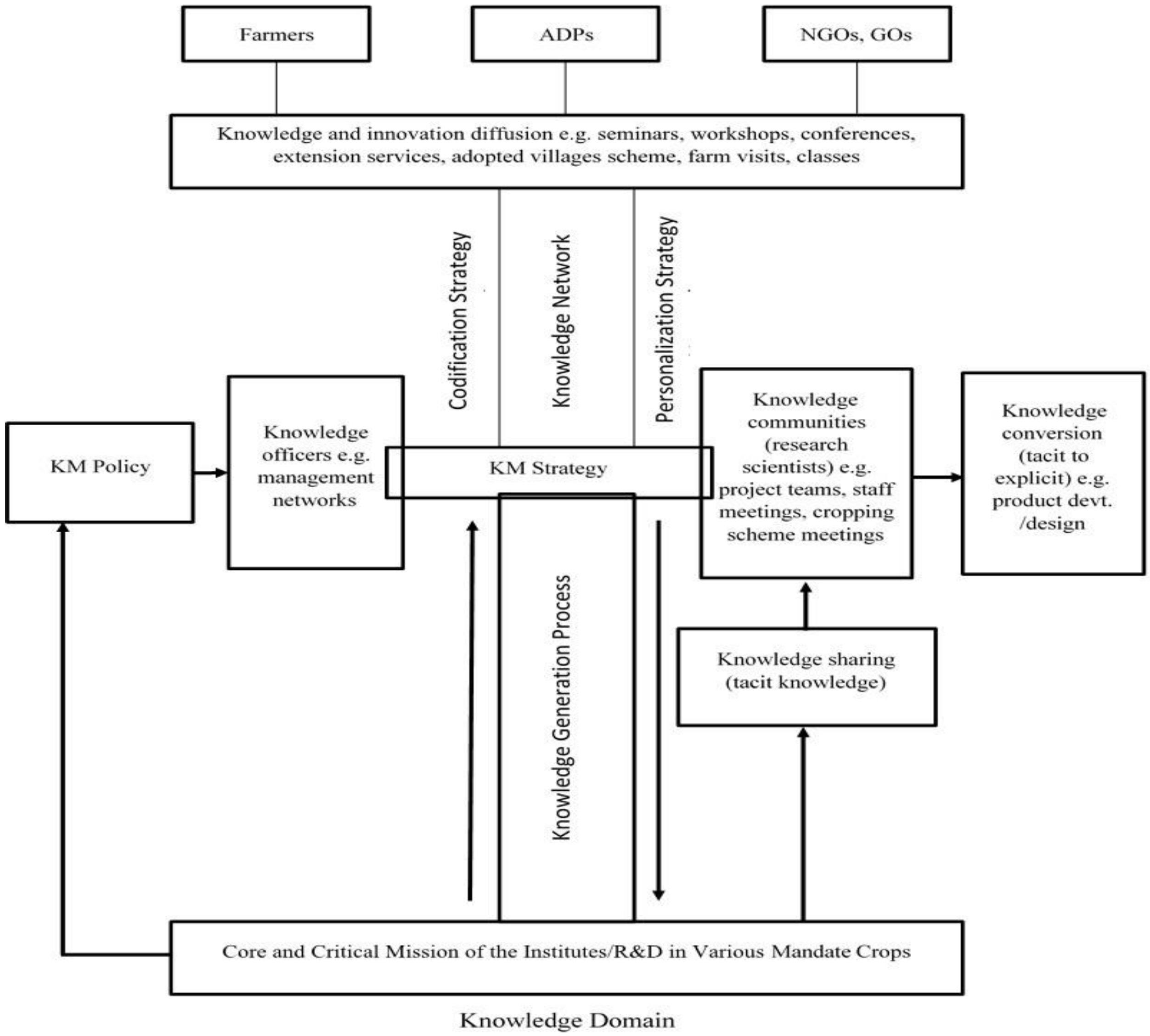

Figure 7.1 Proposed KM model for agricultural research institutes

Knowledge domain: knowledge domain represents the population of knowledge from which to draw, and knowledge bases acquired by the institutes through the production/creation of knowledge, research and development activities in various mandate crops (Zakaria and Nagata, 2010; Yang *et al.,* 2010).

Knowledge generation process: The institutes generate knowledge at three levels: the core and critical mission level; knowledge community level; and management network level. As stated earlier, the core and critical mission of the institutes form an important level of knowledge production and generation through research and development activities in various mandate crops. At the knowledge community level, the institutes' knowledge-generation process is enhanced and amplified through knowledge-sharing. Specifically, tacit knowledge is generated at this level through sharing of practices, expertise and experience by research scientists, in the form of staff meetings, cropping scheme meetings and project teams. Thirdly, the management network plays an important role in the institutes' knowledge-generation process through the management of the total organisational knowledge system at the corporate level. Their role, guided by KM policy, was to articulate grand concepts on what the institutes ought to be, and set the standards for justifying the value of the knowledge that is being created (Nonaka and Takeuchi, 1995).

Knowledge sharing: Knowledge is increasingly perceived as being commercially valuable and its ownership is being recognized by individuals and the organisations in which they work (Brown and Woodland, 1999; Weiss, 1999). Therefore knowledge-sharing has been identified as critical to the management of knowledge in organisations. Knowledge-sharing in this regard provides a link between the individual research scientists and the research institutes, by transferring knowledge that resides within such individuals to the organisational level, where it is converted into economic and competitive value for the organisation (Hendriks, 1999). Cohen and Levinthal (1990) proposed that interactions between individuals who possess diverse and different knowledge enhance the organisation's ability to innovate, far beyond what any one individual can achieve. Boland and Tenkasi (1995) concurred with this idea and submitted that competitive advantage and product success in organisations is the result of individuals with diverse knowledge, collaborating synergistically towards common outcomes.

Knowledge networks: this is a complex and extensive array of KM infrastructure that seeks to organise and communicate knowledge. Knowledge networks are vehicles through which knowledge may be communicated or conveyed to the stakeholders/end users. In other words, knowledge networks enable the generation of agricultural knowledge and local solutions within a supportive social environment (Ingram, 2010). This social learning could encompass a diverse number of actors and networks, including advisors, researchers, non-governmental organisations, policy-makers and farming/supply chain peers. The primary function of knowledge networks is to facilitate partnerships and the exchange of knowledge between all the actors (such as those mentioned above) involved in it through meetings, workshops and conferences.

The research institutes are expected to develop and maintain two forms of knowledge management and transfer modes, in order to ensure efficient and reliable flow of knowledge to their stakeholders. A variety of other networks exists that facilitates the exchange of knowledge, including newsletters, inter-office memoranda, White Papers, professional publications, office libraries, intranet and Internet (Davenport and Prusak, 2000).

KM policy: policy is a deliberate system of principles to guide decisions and achieve rational outcomes. A policy is a statement of intent, and is implemented as a procedure or protocol. Policies can assist in both subjective and objective decision-making. Policies to assist in subjective decision-making would usually assist senior management with decisions that must consider the relative merits of a number of factors before making decisions and, as a result, are often hard to test objectively, e.g. a work-life balance policy. In contrast, policies to assist in objective decision-making are usually operational in nature and can be objectively tested e.g. password policy. In this regard, KM policies will provide directions, procedures and specifications/requirements/standards, in terms of manpower, equipment and legal apparatus for efficient management of knowledge in the research institutes. Modern science and technology policy deals with many functions, among which are planning, budgeting, co-ordinating, administration and promotion of science and technology, and the effective implementation of activities in the area of research and scientific services (Sanni *et al.,* 2001).

Knowledge communities: This is also known as discourse community or community of practice, the main aim of which is to share information and knowledge to achieve collective and individual goals. It is a community of people, groups, or teams that share competencies, experience, ideas, expertise and knowledge (in a specific field of activity), based on a specific knowledge management system defined in the context of a knowledge sharing culture, with a proper ICT system. Knowledge communities such as cropping scheme meetings, and project teams can be viewed as a method by which the agricultural research institutes process innovation. Knowledge communities are often founded to introduce change to a system, organisational or societal, by identifying, creating, representing and/or distributing data, information and/or knowledge in, and via, a community context, on the pretext that more significant value will be created via a knowledge value chain (Argote *et al.,* 2003).

Knowledge conversion: sharing of practices, expertise and experience (tacit knowledge) serve as a stepping stone for knowledge conversion and eventual product design and development. This process is known as externalisation and involves conversion of tacit knowledge into explicit knowledge. In this regard, tacit knowledge becomes explicit, taking the shape of metaphors, analogies, concepts, hypotheses or models (Nonaka and Takeuchi, 1995).

Knowledge and innovation diffusion: this is the process by which an innovation is communicated through certain channels over time, among members of a social system (Rogers, 2003). This is important because an agricultural sector is heterogeneous and, in order for it to be effective, communication needs to be targeted (DEFRA, 2008; Roling, 1998). The important role of knowledge diffusion stems from Lundvall's (1988) notion of interactive learning, as the *raison-d'être* of any innovation system which stresses that innovation happens only where actors of different backgrounds interact. The agri-food chain is characterised by a network of businesses that are aligned to produce food, as well as to manage the associated information flows. This network can be seen as a series of social systems, which interface and overlap. An effective knowledge diffusion in an agricultural sector will deliver increased supply chain agility, increased value of products, services and assets, derive more efficient business cycles, reduced costs, improved animal welfare and husbandry and, finally, more efficient use of resources, knowledge and assets (Manning, 2013).

The model proposed by the present study posits that knowledge diffusion will enable interaction between the knowledge-providers (research institutes) and knowledge-seekers (stakeholders such as farmers, ADPs, policy-makers and farming/supply chain peers) to deliver information such as new research findings; new technology; government incentives and policies; farm management methods; social improvement techniques; water and irrigation systems. It is also hoped that the present study may serve as a model for future research of other agencies in Nigeria and beyond with regard to their KM activities. The channels for delivery can include: personal, face-to-face meetings; farm visits; office, residential fixed-line telephones; cellphones, short messaging systems; handouts, flyers; workshops, seminars, conferences, classes; postal correspondence; emails and weblogs.

For practice, Sekaran (2003) pointed out that the knowledge acquired through research may later be applied to solve problems. This study has provided a deeper understanding of various phenomena pertaining to the KM in the agricultural sector. The findings of the study could serve as a basis for re-evaluation, re-strategising and re-focusing KM practices in the research institutes, as acknowledged by one of the directors interviewed (see Appendix 18), through strengthening the KM activities, such as retention of knowledge, because the capturing and retention of knowledge is the key to avoiding organisational knowledge loss. International Data Corp (2003), an American market research, analysis and advisory firm, specialising in information technology, telecommunications and consumer technology, indicates that 'companies spent $2.7 billion on new knowledge management systems in 2002, and analysts expected the spending to rise to $4.8 billion by 2007' (Logue, 2004). This group estimates that 'Fortune 500 companies' lose US$31.5 billion each year because they do not share knowledge (Logue, 2004).

For society, the findings and recommendations of the present study contribute to the development of the agricultural sector in Nigeria, by triggering attitudinal change that could culminate in effective production and management of knowledge, thereby increasing food production and enhancing revenue generation and food security and reducing poverty in Nigeria.

The originality of the present study lies in the fact that there is a paucity of empirical studies on KM strategies and practices in Nigerian agricultural research institutes, in particular and KM in the Nigerian agricultural sector, in general. A search of the general agriculture-based databases such as ScienceDirect, AGRICOLA, AGRIS, CAB ABSTRACTS and Agricultural Journals via ProQuest, using the string *KM strategies and practices,* revealed a paucity of research work on KM from the Nigerian agricultural research institutes. The search only found seven results that were relevant (AGRICOLA, ScienceDirect, Agricultural Journals in ProQuest, 2014). The few studies found in the Nigerian context were by Charles (2003), Roy (2013), Ekoja (2003), Uganneya (2013), Adimorah (1997) and Nwafor and Salau (2009). These studies focused on agricultural information management, farmers' access to agricultural information, factors inhibiting agricultural research libraries, agricultural librarianship, KM and development targets in Nigeria. However these studies did not cover KM in agricultural research institutes. This point is buttressed by Ajaikaiye and Olusola (2003), who asserted that, in spite of the importance of KM, the attention given to Nigeria's knowledge system in the agricultural sector remains weak.

The present study made use of qualitative and quantitative approaches, as well a combination of various data collection approaches, using survey questionnaires, semi-structured interviews and documentary analysis, to investigate the research problem. The results of such triangulation of approaches provided extensive and diverse sources of information that included types of knowledge generated in the research institutes, namely genetic improvement of varieties of cereals, crops, roots, tubers and barley; wheat, rice, soybeans, sugarcane, beniseeds, millet; crop production, breeding, weed control, value-addition techniques; knowledge-production; knowledge-sharing; knowledge-management strategies, modes of knowledge transmission and communication; challenges of KM (see sections 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8).

Related extant studies from around Africa used different approaches and theoretical lenses (Munyua, 2011; Heffner, 2006; Teruya, 2003; Hall, 2005; Meso, 2001; Halawi, 2005). These studies used theories/models, such as the Delone and Mclean IS success model; the sense-making theory; the social cognitive theory; Wilson's general model of information-seeking behaviour; Meyer's information transfer model; the practitioner and expert evaluation model; the criticism and connoisseurship model; and the client-centred model. The studies also used paradigms such as the pragmatic paradigm and social constructivists' paradigm, while the approaches used includes an experimental design, newspaper content analysis, appraisal of agricultural knowledge systems, unobtrusive observation of activities of farmers and other actors and a participatory rural appraisal method.

The present study also used a pluralistic paradigm, triangulated theories, methodologies and methods that helped the understanding of a multi-disciplinary and multi-faceted nature KM in the agricultural sector of heterogeneous respondents (Creswell, 2009).

The study investigated how concepts and variables from the Nonaka and another six theories/models played out in the Nigerian agricultural research institutes. The study demonstrated the usefulness of these theories and models to the study, in the context of Nigerian agricultural research institutes. The uniqueness of the present study lies in its combination of multiple theories/models in a pioneer study of KM strategies and practices in Nigerian agricultural research institutes.

7.6 Suggestions for future research

The present study investigated the KM strategies and practices in Nigerian agricultural research institutes. The study was limited to five out of 17 agricultural research institutes in Nigeria (see section 4.5). Future research should be conducted in the remaining twelve institutes, to determine the strategies, spractices and challenges of KM in these institutes.

Secondly, since the present study was conducted in government-sponsored organisations in Nigeria, future research could be carried out in private sector organisations, to investigate their KM strategies and practices, and to compare the findings

Since the present study used research questions and research objectives to investigate the research problem, future research could develop hypotheses to determine the strength of the relationships among the dependent variables and independent variables of the study.

Future research could be carried out to determine the impact of application by stakeholders (such as farmers, governmental and non-governmental organisations) of the knowledge produced by the Nigerian agricultural research institutes.

Future research on KM in agricultural research institutes/systems could adopt the model proposed by the present study in order to test and determine the applicability and suitability of its variables in similar studies.

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APPENDICES

APPENDIX 1: Informed Consent Letter (Survey Questionnaire)

UNIVERSITY OF
KWAZULU-NATAL

Information Studies Department

Private Bag X01

Scottsville

3209

Telephone: +27731569121 (SA)

+234-8034236739 (NG)

Email: 213573364@stu.ukzn.ac.za

Kdabbas.lis@buk.edu.ng

05 -05-2014.

Dear Respondent

Informed Consent Letter

I, Kabiru Dahiru Abbas, of University of KwaZulu Natal, kindly invite you to participate in the research project entitled **Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**

This research project is undertaken as part of the requirements of the PhD, which is undertaken through the University of KwaZulu-Natal, Information Studies Department.

The aim of this study is to investigate Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes.

Participation in this research project is voluntary. You may refuse to participate or withdraw from the research project at any stage and for any reason without any form of disadvantage. There will be no monetary gain from participating in this research project. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Department of Information Studies, at the University of KwaZulu-Natal.

If you have any questions or concerns about participating in this study, please feel free to contact myself, my supervisor or the University Research Ethics office at the numbers indicated below.

It should take you about 15 minutes to complete the questionnaire.

Thank you for participating in this research project.

---------------------- --------------------

Signature Date

I……………………………………………………………………………(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Name: .... Date: .... Signature: ....

Supervisor's details

Supervisor: Prof S.M. Mutula

Institution: University of KwaZulu-Natal

Telephone number: +27712750109

Email address: mutulas@ukzn.ac.za

Research Office details

Contact: Mariette Snyman

Humanities and Social Science Research Ethics Office

University of KwaZulu-Natal

Private Bag X54001

Telephone Number: +27312608350

Email address: Snymanm@ukzn.ac.z

Student's details

Researcher: Kabiru Dahiru Abbas

Institution: University of KwaZulu-Natal

Telephone number: +27731569121

Email address: 213573364@stu.ukzn.ac.za

APPENDIX 2: Informed Consent Letter (Interviews)

UNIVERSITY OF
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+234-8034236739 (NG)

Email: 213573364@stu.ukzn.ac.za

Kdabbas.lis@buk.edu.ng

05 -05-2014.

Dear Interviewee

Informed Consent Letter

I, Kabiru Dahiru Abbas, of University of KwaZulu Natal, kindly invite you to participate in the research project entitled **Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**

This research project is undertaken as part of the requirements of the PhD, which is undertaken through the University of KwaZulu-Natal, Information Studies Department. The aim of this study is to investigate Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes. Participation in this research project is voluntary. You may refuse to participate or withdraw from the research project at any stage and for any reason without any form of disadvantage. There will be no monetary gain from participating in this research project. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Department of Information Studies, at the University of KwaZulu-Natal.

If you have any questions or concerns about participating in this study, please feel free to contact myself, my supervisor, or the University Research Ethics office at the numbers indicated below.

It should take you about 15 minutes to complete the interview session.

Thank you for participating in this research project.

---------------------- --------------------

Signature Date

I……………………………………………………………………………(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

Additional consent

I hereby provide consent to:

YES	NO

Audio-record my interview

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Additional

Name: .... Date: .... Signature: ....

Supervisor's details

Supervisor: Prof S.M. Mutula

Institution: University of KwaZulu-Natal

Telephone number: +27712750109

Email address: mutulas@ukzn.ac.za

Research Office details
Contact: Mariette Snyman

Humanities and Social Science Research Ethics Office

University of KwaZulu-Natal

Private Bag X54001

Telephone Number: +27312608350

Email address: Snymanm@ukzn.ac.z

Student's details

Researcher: Kabiru Dahiru Abbas

Institution; University of KwaZulu-Natal

Telephone number: +27731569121

Email address: 213573364@stu.ukzn.ac.za

APPENDIX 3: Introduction Letter to I.A.R. Zaria

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

28th May, 2014

The Director,
Institute for Agricultural Research,
Zaria,
Kaduna State,
Nigeria.

Dear Sir,

RE: Introducing Mr Kabiru Dahiru Abbas – PhD Student at University of KwaZulu Natal

This letter serves to introduce and confirm that Mr Kabiru Dahiru Abbas is a duly registered PhD (Information Studies) candidate at the University of KwaZulu Natal. The title of his PhD research is '**Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**
The outcome from the study is expected to improve practice, inform policy and extent theory in this field of study. As part of the requirements for the award of a PhD degree he is expected to undertake original research in an environment and place of his choice. The UKZN ethical compliance regulations require him to provide proof that the relevant authority where the research is to be undertaken has given approval.
We appreciate your support and understanding to grant Mr Abbas permission to carry out research in your organisation(s). Should you need any further clarification, do not hesitate to contact me.

Thank you in advance for your understanding

Prof Stephen Mutula (Information Studies Programme)

Supervisor and Academic Leader, Development Cluster

University of KwaZulu Natal
Private Bag X01 Scottsville 3209
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APPENDIX 4: Research Permit from I.A.R. Zaria

INSTITUTE FOR AGRICULTURAL RESEARCH, SAMARU

Federal Ministry of Agriculture and Rural Development
Ahmadu Bello University, P.M.B. 1044, Zaria - Nigeria

OFFICE OF THE DIRECTOR

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E-mail: Iar20002001@yahoo.com
iarabuzaria1922@gmail.com

Our Ref: IAR/ADM/1.1

2nd July, 2014.

The Ag. Dean and Head of School,
School of Sciences,
University of KwaZulu Natal.

Dear Professor Mutula,

Introducing Mr. Kabiru Dahiru Abbas PhD Student at KwaZulu Natal

The Director Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, is in receipt of your letter on the above subject matter dated 28th May, 2014. On behalf of the Executive Director, I wish to convey approval, granting permission to your PhD Student, Mr. Kabiru Abbas, to carry out aspects of his research in this Institute.

Thank you with sincere regards.

Yours sincerely,

Professor Ezra B. Amans
For: Executive Director, IAR

APPENDIX 5: Introduction Letter to I.A.R. & T. Ibadan

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

28th May, 2014

The Director,
Institute for Agricultural Research and Training,
Ibadan,
Oyo State,
Nigeria.

Dear Sir,

RE: Introducing Mr Kabiru Dahiru Abbas – PhD Student at University of KwaZulu Natal

This letter serves to introduce and confirm that Mr Kabiru Dahiru Abbas is a duly registered PhD (Information Studies) candidate at the University of KwaZulu Natal. The title of his PhD research is '**Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**
The outcome from the study is expected to improve practice, inform policy and extent theory in this field of study. As part of the requirements for the award of a PhD degree he is expected to undertake original research in an environment and place of his choice. The UKZN ethical compliance regulations require him to provide proof that the relevant authority where the research is to be undertaken has given approval.
We appreciate your support and understanding to grant Mr Abbas permission to carry out research in your organisation(s). Should you need any further clarification, do not hesitate to contact me.

Thank you in advance for your understanding

Prof Stephen Mutula (Information Studies Programme)

Supervisor and Academic Leader, Development Cluster

University of KwaZulu Natal
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APPENDIX 6: Research Permit from I.A.R. & T. Ibadan

INSTITUTE OF AGRICULTURAL RESEARCH AND TRAINING
OBAFEMI AWOLOWO UNIVERSITY
MOOR PLANTATION, P.M.B. 5029, IBADAN, NIGERIA.

J. A. ADEDIRAN, *Dip. (Agric.), M.Sc., Ph.D. (Russia),*
Director *PD Cert. (Res. Mngt.)*

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website: www.iart-ngonline.org

Our Ref: ART/308 Vol. XXI/341 *Your Ref:*.................................... *Date:* 2nd October, 2014

Mr. Dahiru Kabiru A.,
University of Kwazulu Natal,
Private Bag X01 Scottsville 3209,
Pietermaritiburg,
South Africa.

Dear Mr. Dahiru,

ATTACHMENT PROGRAMME IN RESPECT OF A PhD STUDENT - MR. KABIRU DAHIRU ABBAS

I refer to your application on the above subject matter.

I am pleased to inform you that approval has been given for you to undertake your PhD research work in the Library and Documentation Unit of the Institute.

Please note that the Institute will not be responsible for your maintenance and accommodation respectively.

With kind regards.

Yours sincerely,

Nwufoh O. B. (Mrs.)
For: Deputy Registrar/Secretary to the Institute

APPENDIX 7: Introduction to N.R.C.R.I. Umudike

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

28th May, 2014

The Director,
National Root Crops Research Institute,
Umudike,
Abia State,
Nigeria.

Dear Sir,

RE: Introducing Mr Kabiru Dahiru Abbas – PhD Student at University of KwaZulu Natal

This letter serves to introduce and confirm that Mr Kabiru Dahiru Abbas is a duly registered PhD (Information Studies) candidate at the University of KwaZulu Natal. The title of his PhD research is **'Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**
The outcome from the study is expected to improve practice, inform policy and extent theory in this field of study. As part of the requirements for the award of a PhD degree he is expected to undertake original research in an environment and place of his choice. The UKZN ethical compliance regulations require him to provide proof that the relevant authority where the research is to be undertaken has given approval.
We appreciate your support and understanding to grant Mr Abbas permission to carry out research in your organisation(s). Should you need any further clarification, do not hesitate to contact me.

Thank you in advance for your understanding

Prof Stephen Mutula (Information Studies Programme)

Supervisor and Academic Leader, Development Cluster

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Postal Address: Private Bag X01, Scottsville, 3209, South Africa
Telephone: +27 (0) 33 260 5320/5007 Facsimile: +27 (0) 33 260 5092
Email: socialsciences@ukzn.ac.za

APPENDIX 8: Research Permit from N.R.C.R.I. Umudike

NATIONAL ROOT CROPS RESEARCH INSTITUTE
UMUDIKE
FEDERAL MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
P.M.B. 7006, Umuahia, Abia, State. Nigeria.
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NRCRI/C.38/VOL.XXIV/933

24th June, 2014.

Kabiru Dahiru Abbas,
Dept. of Library and Information Sciences,
Bayero University,
Kano.

SUBJECT: LETTER OF CONSENT TO CARRY OUT Ph.D STUDY AT NRCRI.

Reference to your letter dated 23rd June 2014, I have been directed to send you an approval to conduct your research work at NRCRI, Umudike.

Njoku, E. N. (Mrs)
For: Executive Director.

APPENDIX 9: Introduction Letter to N.C.R.I. Badeggi

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

28th May, 2014

The Executive Director,
National Cereals Research Institute,
Badeggi,
Niger State,
Nigeria.

Dear Sir,

RE: Introducing Mr Kabiru Dahiru Abbas – PhD Student at University of KwaZulu Natal

This letter serves to introduce and confirm that Mr Kabiru Dahiru Abbas is a duly registered PhD (Information Studies) candidate at the University of KwaZulu Natal. The title of his PhD research is '**Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes** The outcome from the study is expected to improve practice, inform policy and extent theory in this field of study. As part of the requirements for the award of a PhD degree he is expected to undertake original research in an environment and place of his choice. The UKZN ethical compliance regulations require him to provide proof that the relevant authority where the research is to be undertaken has given approval.

We appreciate your support and understanding to grant Mr Abbas permission to carry out research in your organisation(s). Should you need any further clarification, do not hesitate to contact me.

Thank you in advance for your understanding

Prof Stephen Mutula (Information Studies Programme)

Supervisor and Academic ~~Leader, Development~~ Cluster

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Tel: +27 33 260 5571; +27 712 750 109

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

School of Social Sciences
Postal Address: Private Bag X01, Scottsville, 3209, South Africa
Telephone: +27 (0) 33 260 5320/5007 Facsimile: +27 (0) 33 260 5092
Email: socialsciences@ukzn.ac.za

APPENDIX 10: Research Permit from N.C.R.I. Badeggi

CONFIDENTIAL

NATIONAL CEREALS RESEARCH INSTITUTE

HEADQUARTERS: BADEGGI, PMB 8,BIDA, NIGER STATE, NIGERIA

(FEDERAL MINISTRY OF AGRICULTURE & RURAL DEVELOPMENT)

E-mail: ncribadeggi@yahoo.com

Telephone: 08069314862

Our Ref No 1.16/VOI.3/806

Date July 7, 2014

Mr. Kabiru Dahiru Abbas
Dept. of library and information sciences
Baayero University, Kano

RE: REQUEST FOR A GATEKEEPER CLEARANCE TO CONDUCT PHD RESEARCH.

Your letter dated 30th April, 2014 on the above subject matter refers.

I am hereby directed to convey approval to your request accordingly.

The Institute wishes you a conducive research work.

Thanks for choosing National Cereals Research Institute as one of the case studies in your Research project.

Bakare, S. O

Head of Info. & Doc Dept.

For: Executive Director

CONFIDENTIAL

APPENDIX 11: Introduction Letter to L.C.R.I. Maiduguri

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

28th May, 2014

The Director,
Lake Chad Research Institute,
Maiduguri,
Borno State,
Nigeria.

Dear Sir,

RE: Introducing Mr Kabiru Dahiru Abbas – PhD Student at University of KwaZulu Natal

This letter serves to introduce and confirm that Mr Kabiru Dahiru Abbas is a duly registered PhD (Information Studies) candidate at the University of KwaZulu Natal. The title of his PhD research is '**Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes**

The outcome from the study is expected to improve practice, inform policy and extent theory in this field of study. As part of the requirements for the award of a PhD degree he is expected to undertake original research in an environment and place of his choice. The UKZN ethical compliance regulations require him to provide proof that the relevant authority where the research is to be undertaken has given approval.

We appreciate your support and understanding to grant Mr Abbas permission to carry out research in your organisation(s). Should you need any further clarification, do not hesitate to contact me.

Thank you in advance for your understanding

Prof Stephen Mutula (Information Studies Programme)

Supervisor and Academic Leader, Development Cluster

University of KwaZulu Natal
Private Bag X01 Scottsville 3209
Pietermaritzburg
Email: mutulas@ukzn.ac.za
Tel: +27 33 260 5571; +27 712 750 109

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

School of Social Sciences
Postal Address: Private Bag X01, Scottsville, 3209, South Africa
Telephone: +27 (0) 33 260 5320/5007 Facsimile: +27 (0) 33 260 5092
Email: socialsciences@ukzn.ac.za

APPENDIX 12: Research Permit from L.C.R.I. Maiduguri

LAKE CHAD RESEARCH INSTITUTE MAIDUGURI FMA & RD

OFFICE OF THE EXECUTIVE DIRECTOR

LAKE CHAD RESEARCH INSTITUTE MAIDUGURI

FEDERAL MINISTRY OF AGRICULTURE & RURAL DEVELOPMENT

Gamboru Ngala Road, P.M.B. 1293, Tel: 076-960300, 960302, Maiduguri - Borno State.

Website:www.LCRImaid.gov.ng

Ref. No. LCRI/ED.2/I/232 23rd May, *2014.*

Department of Library & Information Sciences,
Bayero University,
Kano.

RE: REQUEST FOR A GATEKEEPER CLEARANCE

I wish to refer to your letter dated 26th March, 2014 on the above subject matter: "***Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes***". Having gone through the Proposal, I consider it timely and very vital to those of us in the research sector.

I therefore wish to grant an express clearance for the candidate to conduct his Ph. D research in our Institute knowing the result will be of immense benefit to us and other research Institutes.

Accept my warm regards.

Dr. O. G. Olabanji,
Executive Director.

APPENDIX 13: Questionnaire for researchers in the institutes

INSTRUCTION: Please tick (√) the appropriate box or provide written answer where space is provided

SECTION A: BACKGROUND INFORMATION

1. Name of the Institute:
    a. I.A.R. Zaria ( )
    b. I.A.R. & T. Ibadan ( )
    c. N.R.C.R.I. Umudike ( )
    d. N.C.R.I. Badeggi ( )
    e. L.C.R.I. Maiduguri ( )
2. Department/Unit of Respondent:
    a. Agric Econs & Extension Programme ( )
    b. Farming System ( )
    c. Biotechnology ( )
    d. Product Development Programme ( )
    e. Research Outreach ( )
    f. Others ( )
3. How long have you being working in this department/unit?
    a. 1-3 years ( )
    b. 4-7 years ( )
    c. 8-11 years ( )
    d. 12-15 years ( )
    e. Above 16 years ( )
4. In which other department/unit have you worked in the past five years?
    a. Agric Econs & Extension Programme ( )
    b. Farming System ( )
    c. Biotechnology ( )
    d. Product Development Programme ( )
    e. Research Outreach ( )

f. Others ( )

5. Position/Rank of the respondent:
   a. Research Officer levels 1&II ( )
   b. Principal Research Officer ( )
   c. Principal Laboratory Technician ( )
   d. Senior Research Officer ( )
   e. Professor ( )
   f. Others ( )

6. Age: a. 18-28 ( ) b. 29-38 ( ) c. 39-48 ( ) d. 49-58 ( ) e. above 58 ( )
7. Gender: a- Male ( ) b- Female ( )
8. Educational level:
   a. Diploma/HND/NCE ( )
   b. Bachelor's Degree ( )
   c. Master's Degree ( )
   d. PhD ( )

SECTION B: TYPE OF KNOWLEDGE GENERATED

9. What type of knowledge is generated in your research institute?

   …………………………………………………………………………………………

10. In which area(s) does your institute conduct research?

    …………………………………………………………………………………………

11. How do you rate the level of knowledge production in your institute?
    a. Very high ( )
    b. High ( )
    c. Low ( )
    d. Very low ( )
12. How do the staff share information and knowledge in your institute?

    …………………………………………………………………………………………..

13. How do you compare the generation of knowledge through interaction (tacit knowledge) in relation to generation of knowledge through documents(explicit knowledge) in your institute?

S/N	Types of Knowledge	Very Low	Low	High	Very High
a.	Explicit Knowledge				
b.	Tacit Knowledge				

SECTION C: EXTENT OF KNOWLEDGE PRODUCTION

14. How is knowledge produced in your institute?

    ………………………………………………………………………………………

15. How regularly does your institute produce knowledge?
    a. Very regularly ( )
    b. Regularly ( )
    c. Sometimes ( )
    d. Rarely ( )
16. What is the extent of knowledge production in the institute?
    a. Very often ( )
    b. Often ( )
    c. Occasional ( )
    d. Some times ( )
17. Which of the following knowledge management activities are performed in your research institute?

S/N	KM Activities	Performed	Not Performed
a.	Knowledge identification		
b.	Knowledge acquisition		
c.	Knowledge creation		
d.	Knowledge organization		
e.	Knowledge transfer		
f.	Knowledge application		

g.	Knowledge adoption		

18. Please indicate the activities that lead to the production of knowledge and frequency of these activities:

S/N	**Statements**	**Very Frequently**	**Frequently**	**Occasionally**	**Sometimes**	**Never**
a.	Interpersonal discussion with colleague					
b.	Workshops, seminars, and conferences					
c.	Research and consultancy					
d.	Memos, reports and files					
e.	Publication such as magazines, newsletters etc					
f.	Online and offline databases search					
g.	Others (please specify)					

19. Do you share information, ideas, expertise and experience with colleagues?
    a. Yes ( ) b. No ( ) If yes explain how………………………………..

20. Please tick the category of colleagues with which you share your knowledge:
    a. Junior ( )
    b. Senior ( )
    c. Management ( )
    d. All ( )
21. Does your institute organize any training/seminars/workshops to build the capacity of staff for enhanced knowledge management and productivity?
    a. Yes ( ) b. No ( )
22. If yes, how many training/seminars/workshops have you attended in the past one year?
    a. None ( ) b. Once ( ) c. Twice ( ) d. Three times ( ) e. Four times ( ) f. More than four times ( )
23. How often your institute does engaged in research and development activities?
    a. Very often ( )
    b. Often ( )
    c. Occasionally ( )
    d. Never ( )

SECTION D: KNOWLEDGE MANAGEMENT STRATEGIES

24. Which one of the following Knowledge Management Best Practice tools adopted by your institute?
    a. Community of Practice ( )
    b. Community of Knowledge ( )
25. Which of the following Knowledge Management resources and techniques are available in your institute?
    a. Cross-functional project teams ( )
    b. KM training and education ( )
    c. Storytelling ( )

d. Mentoring ( )

26. Which of the following Knowledge Management initiatives are adopted for enhanced productivity in your institute?

S/N	**KM Initiatives**	**Available**	**Not available**
a.	Identification of existing knowledge		
b.	Improved documentation of existing knowledge		
c.	Changing (parts of) of the organizational culture		
d.	Improving co-operation and communication		
e.	Externalization (turn 'tacit' to 'explicit')		
f.	Improving training, education and networking of newly recruited employees		
g.	Improving training and education of all employees		
h.	Improving retention of knowledge		
I.	Improving access to existing sources of knowledge		
j.	Improving acquisition or purchasing of external knowledge		
k.	Improving distribution of knowledge		
L.	Improving management of innovations		
m.	Reduction of costs		
n.	Others (please specify)		

27. Which one of the following Knowledge Management Strategies is primarily used in your institute?
    a. System strategy (ICTs-based KM practice) ( )
    b. Human strategy (social network and interaction) ( )

28. Which of the following skills are available for the management of knowledge in your institute?

S/N	Skills	Available	Not available
a.	Processing factual and theoretical knowledge		
b.	Finding and accessing knowledge		
c.	Ability to apply knowledge		
d.	Knowledge integration and re-combination		
e.	Others (please specify)		

29. Which of the following specialists does your organization have to attend to and manage the knowledge management system?

S/N	Specialists	Available	Not available
a.	Network administrator		
b.	Database administrator		
c.	Maintenance technician		
d.	Data entry operators		
e.	Others (please specify)		

SECTION E: DISSEMINATION OF KNOWLEDGE

30. Which of the following is available and accessible to you in the institute?

S/N	Statements	Available and accessible	Available but not accessible	Not available
a.	The experiences (tacit knowledge) of staff who have retired from service/employment			
b.	The experience (tacit knowledge) of staff who have transferred from your department/unit			
c.	The experience (tacit knowledge) of staff who are transferred to your department/unit			
d.	The minutes of meetings (explicit knowledge)			
e.	Research findings/results (explicit knowledge)			
f.	Internal/external memos (explicit knowledge)			
g.	Official letters/files (explicit knowledge)			

31. What is the mode of transmission/communication of the information and knowledge to your stakeholders?
    a. Through personal contact ( )
    b. Email alert/current awareness services ( )
    c. Selective dissemination of information ( )
    d. Newsletters/bulletins ( )
32. Are there any conditions prescribed for access and utilization of information and knowledge in your institute?
    a- Yes ( )
    b- No ( )
33. If yes, please explain:
    1. …………………………………………………………………………………
    2. ………………………………………………………………………………
    3. ………………………………………………………………………………
    4. ………………………………………………………………………………

34. Please indicate the source(s) through which you acquire information and knowledge in your institute
    a. Colleagues ( )
    b. Research reports and newsletters ( )
    c. Learn by doing ( )
    d. Internet and Institute's database ( )
    e. Others (please specify)………………………

SECTION F: KNOWLEDGE MANAGEMENT INFRASTRUCTURE

35. Please indicate the Knowledge Management resources available in your institute
    ……………………………………………………………………………………………
    ……………………………………………………………………………………………
    …………………………………………………………………………………

36. Please indicate which of the following Documents Management Systems are available in your institute?
    a. Group directories ( )
    b. Archives ( )
    c. Other repositories ( )
    d. Other (please specify)……………..
37. Which of the following Knowledge Management Systems (KMS) are available in your institute?

S/N	Knowledge Management Systems	Available	Not available
a.	Community of Practice		
b.	Personal Networks		
c.	Document Management System		
d.	Expert Systems		
e.	Organizational Practice and Routines		
f.	Training		
g.	Informal Networks		
h.	Groupware		
I.	Internet and Magazines		
j.	Other (please specify)		

SECTION G: FACTORS INFLUENCING KNOWLEDGE MANAGEMENT ADOPTION

38. Please indicate the methods/channels you use to communicate your knowledge to the institute:
    a. Memo ( )
    b. Sharing with Colleagues ( )
    c. Informing your boss ( )
    d. Staff meetings ( )
    e. Other (please specify)…………………….

39. Do you hold formal staff meetings in your institute?

a. Yes ( )

b. No ( )

40. If yes, how often do you hold these staff meetings?

a. Monthly ( )

b. Quarterly ( )

c. Biannually ( )

d. Annually ( )

e. Other (please specify)………………

41. Where are the minutes of the staff meetings kept?

a- Boss's office ( )

b- Library/Documentation office ( )

c- General office ( )

d- Others (please specify)…………………………….

42. Please rank the soundness of the group work Relationship that exist between bosses and subordinates in your organization

a. Very High ( )

b. High ( )

c. Indifferent ( )

d. Low ( )

e. Very Low ( )

43. Does this relationship help in the flow of information and sharing of knowledge?

a. Yes ( )

b. No ( )

44. If yes, please rank 1-5 with '1' being lowest and '5' highest, the extent to Which it helps:

a. 1 ( )

b. 2 ( )

c. 3 ( )

d. 4 ( )

e. 5 ( )

45. The following statements describes the knowledge friendly culture in your institute:

S/N	Statements	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
a.	The manner in which things are done makes the sharing of your experience and knowledge with others difficult.					
b.	The sharing of your experience and knowledge with others is enhanced by the way in which things are done in your institute.					
c.	Communication in your institute only comes from the top management down to the subordinates.					
d.	Knowledge creation, codification and transfer is made part of the institute's culture.					
e.	Research results are accessed easily by the stakeholders.					

f.	New staff are taught about the job by older/experienced staff in the course of performing their duties (mentoring).					
g.	Induction courses are organized for the new staff in the institute.					

46. Please indicate how you know about events in your institute and how often are these held?

S/N	Statements	Very often	Often	Occasionally	Sometimes	Never
a.	By word of mouth (verbal)					
b.	Communication through letters					
c.	Memos					
d.	Minutes of meetings					
e.	Emails					
f.	Gazettes and government publications					
g.	Speculation					
h.	Other (please specify)					

SECTION H: CHALLENGES OF KNOWLEDGE MANAGEMENT

47. Which are the following challenges faced by your institute with regards to Knowledge Management practice?

S/N	Challenges	Available	Not available
a.	Lack of performance indicators and measurable benefits		
b.	Inadequate management support		
c.	Improper planning, design, co-ordination and evaluation		
d.	Inadequate skills of knowledge managers and workers		
e.	Problems with organizational culture		
f.	Improper organizational culture		
g.	Loss of knowledge from staff defection and retirement		
h.	Lack of synergy among knowledge creating crew (knowledge officers, knowledge engineers, and knowledge practitioners)		
I.	Other (please specify)		

APPENDIX 14: Interview Schedule with Institutes' Directors

A. QUESTIONS ON RESPONDENT AND THE INSTITUTE

1. Please could you describe your institute's focus of activities?

   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………

2. Explain the activities/services that your institute is engaged in:

   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………

B. QUESTIONS ON THE TYPES OF KNOWLEDGE GENERATED

3. What types of knowledge are generated and managed by your institute?

   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………

4. How do knowledge generation and management complement the attainment of your institute's goals?

   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………
   ……………………………………………………………………………………

5. How do you compare the generation of explicit knowledge in relation to tacit knowledge in your institute?

   ……………………………………………………………………………………
   ……………………………………………………………………………………

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C. **QUESTIONS ON EXTENT OF KNOWLEDGE PRODUCTION**

6. How would you describe the way in which knowledge is produced and managed in your institute?

   …………………………………………………………………………………

   …………………………………………………………………………………

   …………………………………………………………………………………

   …………………………………………………………………………………

7. How would you describe the way in which knowledge is shared among staff across departments/units in your institute?

   …………………………………………………………………………………

   …………………………………………………………………………………

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   …………………………………………………………………………………

8. How do new staff access the experience/knowledge of those staff leaving the institute and retirees?

   …………………………………………………………………………………

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   …………………………………………………………………………………

9. Are there ways in which your institute has been able to store this information/resources for others to access?

   …………………………………………………………………………………

   …………………………………………………………………………………

   …………………………………………………………………………………

   ……………………………………………………………………..

D. QUESTIONS ON KNOWLEDGE MANAGEMENT STRATEGIES

10. Does your institute have a Knowledge Management Policy?

    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………

11. Does the organizational structure recognize the post of knowledge manager within your institute?

    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ……………………………………………………………………………………….

12. Does your institute have a knowledge management department?

    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ……………………………………………………………………………………

13. What knowledge management strategic initiatives are available in your institute?

    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ………………………………………………………………………………………

14. Has a knowledge audit ever been conducted in your institute and how regular does this take place?

    ………………………………………………………………………………………
    ………………………………………………………………………………………
    ……………………………………………………………………………………….

15. What knowledge management best practices have been adopted by your institute?

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

16. Does your institute's organizational structure provide for the post of knowledge manager?

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………………………………………………………………………………………
……………………………………………………………………………………….

17. What knowledge management infrastructure is available and to what extent does this contribute to effective knowledge management practices in your institute?

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………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

18. What knowledge management strategies are available for enhanced productivity in your institute?

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………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

19. How often does your institute train its staff for innovation and effective knowledge management so as to attain a competitive advantage?

………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………
……………………………………………………………………………

E. QUESTIONS ON KNOWLEDGE MANAGEMENT INFRASTRUCTURE

20. What knowledge management infrastructure is available in your institute?

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

21. What facilities are available for knowledge management in your institute?

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

    ………………………………………………………………………………….

F. QUESTIONS ON KNOWLEDGE DISSEMINATION

22. What are the principles governing the dissemination of knowledge in your institute?

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

23. How does your institute disseminate the knowledge it has generated to your stakeholders?

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

    ………………………………………………………………………………….

24. How does your institute channel the knowledge generated for national development?

    …………………………………………………………………………………

    …………………………………………………………………………………

    …………………………………………………………………………………

25. How often does your institute carry out extension services for an improved farming system?

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

26. How regularly does your institute organize workshops/seminars and conferences for stakeholders?

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…………………………………………………………………………………
…………………………………………………………………………………

27. Is there a database or any other repository in which institute's knowledge can be accessed?

…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

28. Does your institute encourage staff to share knowledge among themselves?

…………………………………………………………………………………
…………………………………………………………………………………
………………………………………………………………………………

29. How do you describe staff's attitude towards knowledge management in your institute?

…………………………………………………………………………………
…………………………………………………………………………………
……………………………………………………………………………

30. Are you comfortable to share knowledge with others?

…………………………………………………………………………………
…………………………………………………………………………………
……………………

31. Does management, senior and junior staff, have any informal avenues for interaction and collaboration?

………………………………………………………………………………………
………………………………………………………………………………………
…………………………………

32. Have you experienced a situation where a staff member is reluctant to share knowledge with other staff?

………………………………………………………………………………………
………………………………………………………………………………………
……………………………………………………………………………

33. Do you think a bureaucratic culture helps in facilitating the knowledge management practices in your institute?

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………………………………………………………………………………………
………………………………………………………………………………………
………………

34. How does organizational culture encourage knowledge management practices such as knowledge sharing in your institute?

………………………………………………………………………………………
………………………………………………………………………………………
…………………………………………………………………………….

35. How would you describe the role that the regular/routine activities and tasks you performed play in knowledge management?

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………………………………………………………………………………………

36. Is there any issue or concern that you would like to mention regarding the knowledge management strategies and practices in your institute?

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………………………………………………………………………………………
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APPENDIX 15: Interview Schedule with Heads of Information and Documentation Units

A. QUESTIONS ON RESPONDENT AND THE INSTITUTE

1. Please could you describe your job?

…………………………………………………………………………………

…………………………………………………………………………………

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2. Please describe activities/services that your institute is engaged in:

…………………………………………………………………………………

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B. QUESTIONS ON THE TYPES OF KNOWLEDGE GENERATED

3. What types of knowledge are generated and managed by your institute?

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4. How does knowledge generation and management complement the attainment of your institute's goals?

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5. How do you compare the generation of explicit knowledge in relation to tacit knowledge in your institute?

   ………………………………………………………………………………

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C. QUESTIONS ON EXTENT OF KNOWLEDGE PRODUCTION

6. How would you describe the way in which knowledge is produced and managed in your institute?

   …………………………………………………………………………………

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   …………………………………………………………………………………

7. How would you describe the way in which knowledge is shared among staff across departments/units?

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   …………………………………………………………………………………

8. How do new staff access the experience/knowledge of those staff leaving the institute and retirees?

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9. Are there ways in which your institute has been able to store this information for others to access?

   …………………………………………………………………………………

   …………………………………………………………………………………

D. QUESTIONS ON KNOWLEDGE MANAGEMENT STRATEGIES

10. Does your institute have knowledge management policy?

    …………………………………………………………………………………

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11. Does your organizational structure recognize the post of knowledge manager?

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12. Does your institute have a knowledge management department?

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13. What knowledge management strategic initiatives are available in your institute?

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14. Has a knowledge audit ever been conducted in your institute and how regularly does this take place?

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……………………………………………………………………………….

15. What knowledge management best practices are adopted by your institute?

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16. Does your institute's organizational structure provide for the post of knowledge manager?

…………………………………………………………………………………………

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………………………………………………………………………………………

17. What knowledge management infrastructure is available and to what extent does this contribute to effective knowledge management practices in your institute?

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18. What knowledge management strategies are available for enhanced productivity in your institute?

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19. How often does your institute traine its staff for innovation and effective knowledge management so as to attain a competitive advantage?

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E. QUESTIONS ON KNOWLEDGE MANAGEMENT INFRASTRUCTURE

20. What knowledge management infrastructure is available in your institute?

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21. What facilities are available for knowledge management in your institute?

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F. QUESTIONS ON KNOWLEDGE DISSEMINATION

22. What are the principles governing the dissemination of knowledge in your institute?

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23. How does your institute disseminate the knowledge it has generated to stakeholders?

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24. How does your institute channel the knowledge generated for national development?

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25. How often does your institute carry out extension services for an improved farming system?

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26. How regularly does your institute organize workshops/seminars and conferences for stakeholders?

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27. Is there a database or any other repository in which institute's knowledge can be accessed?

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28. Does your institute encourage staff to share knowledge among themselves?

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29. How do you describe staff attitudes towards knowledge management in your institute?

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30. Are you comfortable to share knowledge with others?

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31. Does management, senior and junior staff, have any informal avenues for interaction and collaboration?

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32. Have you experienced a situation where a staff member is reluctant to share knowledge with other staff?

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33. Do you think a bureaucratic culture helps in facilitating the knowledge management practices in your institute?

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34. How does organizational culture encourage knowledge management practices such as knowledge sharing in your institute?

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35. How would you describe the role that the regular/routine activities and tasks you perform play in knowledge management?

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36. Is there any issue or concern that you would like to mention or share regarding the knowledge management strategies and practices in your institute?

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APPENDIX 16: Documentary Analysis Checklist

As the third instrument for the collection of data in this study, the documentary analysis focuses on the following:

1. To look into the policy issues governing the knowledge management practice in the Nigerian Agricultural Research Institutes.

2. To look into the knowledge management strategic plan and road map in each of the five research institutes.

3. To study the extent to which explicit knowledge (knowledge in documents, databases and other repositories) is produced and managed by the institutes.

4. To look at the instances of knowledge management application such as New Product Developed by the institutes.

APPENDIX 17: Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

08 October 2014

Mr Kabiru Dahiru Abbas (213573364)
School of Social Sciences
Pietermaritzburg Campus

Protocol reference number: HSS/1070/014D
Project title: Knowledge Management Strategies and Practices in Nigerian Agricultural Research Institutes

Dear Mr Abbas,

Full Approval – Expedited Application

With regards to your response received on 26 September 2014 to our letter dated 19 September 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....

Dr Shenuka Singh (Chair)

/ms

Cc Supervisor: Professor SM Mutula
Cc Academic Leader Research: Professor Sabine Marschall
Cc School Administrator: Ms Nancy Mudau

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

APPENDIX 18: Analysis of the Semi-structured Interviews Conducted with the Directors of the Four Agricultural Research Institutes of Nigeria

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
About the Institute	I.A.R. has a goal to generate, disseminate and impart improved agricultural technologies for enhanced crop production and utilization for self-sufficiency in food, raw materials and for export.	The I.A.R. &T. is a multicommodity research institute.	N.R.C.R.I is an agricultural research institute set up by the federal government of Nigeria to conduct research on root and tuber crops.	Parastatal under federal Ministry of Agriculture charged with the mandate for genetic improvement of wheat, millet and barley; and total farming systems and extension in north eastern Nigeria (Adamawa, Bauchi, Borno, Gombe and Yobe states).
Activities/services which the institute engaged in	National genetic mandate on nine crops: cotton, cowpea, ground nut, maize, sorghum, artemisia, jetropha, castor. Dissemination of agricultural research-based information to stakeholders.	Research (generation/development and dissemination of technologies); training of farmers, middle level manpower and graduates in agriculture; consultancy services in agricultural production.	Research into genetic improvement of root and tuber crops; agricultural extension services in liaison with states and federal agencies; provide technical/vocational training to farmers, students and other stakeholders; farming systems based research for south eastern Nigeria.	Genetic improvement of wheat, millet and barley; farming systems and extension research; training of farmers and stakeholders; generation of agricultural technologies, information and documentation.
Types of knowledge generated and managed by the institute	Basic and applied research in areas mentioned above.	Mostly scientific data, knowledge in agriculture; information on science and nature; research findings from scientific investigations; national and international information in agriculture.	Results of experiments aimed at addressing the needs of farmers and other stakeholders; technological packages for optimum productivity.	Agricultural technologies (research).

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
Knowledge generation and management versus institute's goals	The utilization of knowledge generated and managed compliment very well our institute's goals through improved productivity in the farming system of our mandate areas.	The institute's mandate is to research into vital areas in agriculture; it consists of over 80 research personnel who are involved in generation of knowledge which is highly complementary to the activities of the institute.	Development of these technological packages and their dissemination are goals or mandates of the institute.	Technology generation and information sharing, data management and documentation are the hallmarks of the institute.
Explicit knowledge generation and tacit knowledge generation in the institute	Both types of knowledge are produced in the institute through interaction and documentation of research findings.		Both types of knowledge are generated by my institute. Knowledge generated by regular interaction between scientists and management is documented. Documented knowledge is disseminated among scientists, sometimes through interaction. The two types of knowledge are interwoven and complimentary.	Explicit knowledge helps in popularizing the institute's mandate and activities to clientele and stakeholders.
Knowledge production and management in the institute	Very high considering the fact that the primary responsibilities of the institute is research and development.	Literature search from internet is satisfactory; conduct of research is intensive; production of scientific publications is high; use of library, information technology is not high.	Knowledge is produced on a regular basis through research. Results are documented on a regular basis through annual reports published by the institute and through journals published by scientists.	Regular dissemination to stakeholders; information and documentation, agricultural extension department; data processing, report writing, extension annual reports, newsletters, extension guides, television and radio programmes

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
Knowledge sharing among staff across departments/units	Knowledge sharing is taking place through review meetings, cropping schemes meetings, seminars, workshops, conferences.	Interconnectivity is developed; adequate planning meetings, seminars, workshops, meetings, group/personal interactions.	Through interaction and journals; through station seminars; newsletters, fact sheaths and memos.	Frequent and efficient departmental seminars; staff general meetings; quarterly and annual review meetings.
Ways in which new staff accessed the experience/knowledge of the older ones	Through our libraries, seminars, workshops.	Induction; seminars; Mentorship; personal interaction.	Through mentoring (on the job); and published research work.	Publications; mentoring; seminars; documentaries.
Knowledge documentation and storage for others to access	Yes, through review meetings, cropping scheme meetings, journals and workshops.	Documentation; computerization; publication; newsletters, bulletins, journals, conference proceeding; manuals; use of archives.	Through hard copy and e-library.	Publications; information and documentation unit (library); documentaries.
Knowledge management policy	No.	No.	No.	Yes, but not in written format.
Post of knowledge manager in the institute's organizational structure	No, but we have librarians and extension personnel who serve as institute's repositories.	Not exactly.	We have a Director of information and documentation.	Yes, Head of information and documentation.
Knowledge management department	yes	Yes	We have information and documentation division	Information and documentation unit; agricultural economics and extension department.

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
Knowledge management strategic initiatives available in the institute	Project teams; mentoring.	Electronic data management; record keeping; subscription of data, information, publication through internet facility.	Knowledge identification; knowledge creation; knowledge transfer; and knowledge organization.	Technology generation departments (cereals and farming systems research department); extension research and dissemination of technologies; information documentation.
Conducting knowledge audit in the institute	Yes, sometimes.	No.	A skill gap analysis has been carried out.	Agricultural research council verification – quarterly.
Knowledge management best practices adopted by the institute	Community of knowledge has been adopted and practiced in the institute.	Use of electronic database and accessing information from archives.	Community of practice and community of knowledge.	Technology generation, extension services and documentation.
Knowledge management crew in the institute	Yes, all our research scientists are the embodiment of knowledge and knowledge production	No, but culture of knowledge sharing by researchers is entrenched and institutionalized.	Not exactly but we have data processor, confidential secretaries, computer operators etc.	Yes, Head of information and documentation unit.
Knowledge management infrastructure in the institute		Library and documentation unit; public relation unit; publication unit; library and head of information and documentation (personnel).	We have a standard computer unit, a standard library. These have contributed effectively in the actualization of the institute's mandate.	Library (ICT, E-library); media studio; conference hall/training centre; training facilities.
Knowledge management strategies for productivity in the institute	Training and re-training of staff to improve their skills and share knowledge.	Use of electronic library; use of interconnected networks; subscribing to local and foreign publications.	Improving access to existing knowledge through connection of staff to internet; improving knowledge retention through documentation of research findings; dissemination of knowledge.	Improved generation of information and innovation management.

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
Staff training for innovation and knowledge management to attain competitive advantage	Very often through periodic departmental seminars, workshops and conferences (both local and international).	Not quite often.	Staff are sent on regular training and refresher courses to enable them to update their knowledge.	The institute is active in sending its researchers on short courses to improve their skills and technical know-how.
knowledge management resources in the institute	Librarians and ICT facilities and experts.	Library; publication unit, farming system research and extension program; information and documentation unit; public relations section.	Computer/ICT centre; digital library; statistics and documentation unit.	E-library; media studio; conference/training hall; training facilities.
Facilities for knowledge management in the institute	Library; reading rooms; ICT facilities; newsletters; bulletins.	Library shelves and archives; computers for interconnectivity.	Same as above.	Video camera; projectors; recording studio; teaching and demonstration aids.
Principles governing the dissemination of knowledge in the institute		Easy process for documentation; effective data processing; fast information/data retrieval and effective in data/information sharing.	The institute is statutorily required to disseminate research findings to end-users, especially farmers, and to train middle level manpower in agriculture.	Free access with consent of Executive Director following stated regulation.

Themes	Director I.A.R. Zaria	Director I.A.R. & T. Ibadan	Director N.R.C.R.I. Umudike	Director L.C.R.I. Maiduguri
Dissemination of knowledge generated to stakeholders	Through meetings; crop schemes; workshops and seminars.	Organizing conferences, workshops, seminars; presentations at the above fora; organizing farm visits and demonstrations; formal and informal interaction with farmers and policy makers.	Through training and workshops organized for stakeholders; through meetings with Agricultural Development Partners (ADPs) and other forms of collaborations.	Publications, seminars, workshops and documentaries.
Channeling of knowledge generated for national development	Through memos, workshops, seminars and other meetings.	Linkage with Agricultural Development Partners (ADPs) – extension arm of the States' Ministry of Agriculture; delivery of extension services; writing and presentation of research reports.	Research findings are transferred through ADPs to farmers for adoption, thus enhancing farmers' welfare and ultimately national development.	Technology transfer and extension services to farmer thereby improve farming practices for overall national development.
Workshops/seminars and conferences for the stakeholders	Very often held (normally monthly) because it is one of the cardinal objectives of the institute to make available the research findings.	We organize such fora on a quarterly basis.	Regularly.	Monthly, quarterly and annually.
Role of regular /routine activities and tasks in knowledge management	It helps in the management, generation and sharing of knowledge throughout the institute.	Positive role, enhance safe keeping and documenting and mastering of knowledge.	It really plays important role because every activity is a knowledge management tool in a research institute like ours.	It encourage documentation, report writing and management of data in the institute.
Other issues or concerns regarding knowledge management strategies and practices in the institute	Nothing, but this institute will continue to harness its human capital for improved agriculture in Nigeria.	This interview has sensitize me on the need for knowledge auditing and knowledge management activities.	Declining resources are adversely affecting our ability to upgrade further some of our knowledge management infrastructure.	No comment and thank you.

APPENDIX 19: Analysis of the semi-structured interviews conducted with Heads of Information and Documentation of the four Nigerian Agricultural Research Institutes

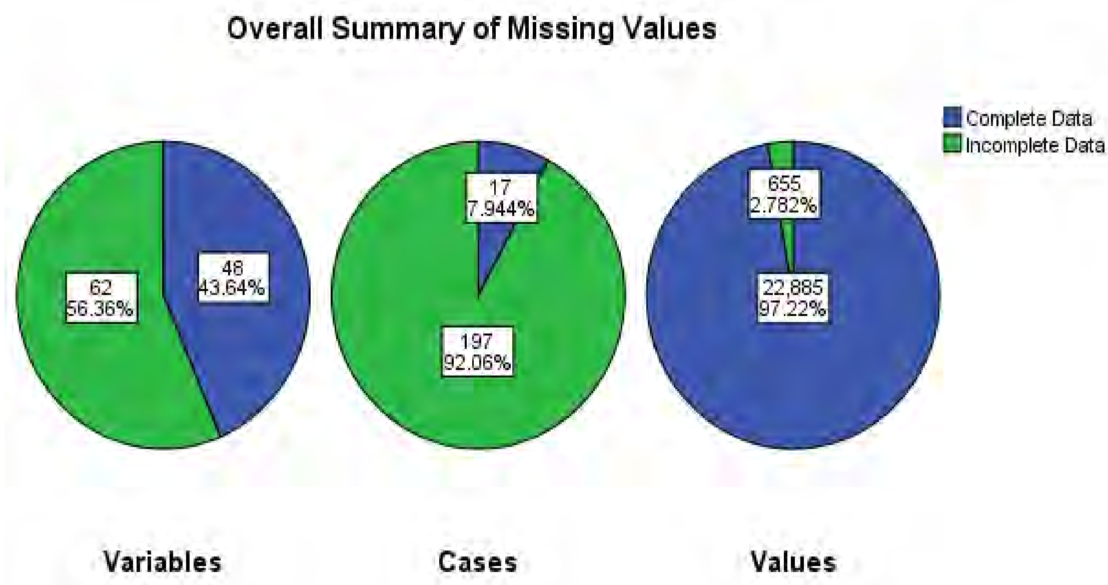
Themes	Head of Information and Documentations I.A.R. Zaria	Head of Information and Documentations I.A.R. & T. Ibadan	Head of Information and Documentations N.R.C.R.I. Umudike	Head of Information and Documentations N.C.R.I. Badeggi
Job Description	Collection, dissemination and documentation of research information/technologies to our stakeholders.	Co-ordinating all the activities of the information and documentation unit; research into agricultural information/literature for better services; provide information services to research scientists to compliment the research mandate of the institute.	Provision of information to users, especially agricultural researchers in the institute; documentation of research reports and research findings.	Supervise and monitor staff in the department to ensure dedication and hard work; collection and documentation of research findings for overall national development; represent the Executive Director as need arises.
Activities/services of the institute	Genetic improvement of cowpea, sorghum, maize, jetropha, castor groundnut, artemisia, sunflower and cotton.	Research into soil, kenaf, jute, cereals, grain legumes, trypanotolerant, livestock, snails, rabbit, pigs and product development of crops such as soya milk etc.	Research into genetic improvement of root and tuber crops; yam, cocoyam, cassava, potato, sweet potato, ginger and other exotic roots and tubers.	Research on the genetic improvement of mandate crops – rice, sugarcane, soya bean, castor, beniseed, and the farming systems in the north central zone of Nigeria.
Types of knowledge generated and managed by the department	Basic knowledge on crop management and dissemination of research findings to end-users.	Research results and new technologies in the different mandates of the institute; improved resistant varieties, crops and livestock-breeds.	Traditional agricultural practices of the south east, south-south and other agro-ecological zones in Nigeria; scientific research and developments in agriculture.	Research results and research findings.

Themes	Head of Information and Documentations I.A.R. Zaria	Head of Information and Documentations I.A.R. & T. Ibadan	Head of Information and Documentations N.R.C.R.I. Umudike	Head of Information and Documentations N.C.R.I. Badeggi
Knowledge generation and management in the institute	Through on-farm demonstration, the institute was able to improve farming practices, thereby attaining its goals.	Substantial achievements have been recorded in terms of adoptable and adaptable technologies that have made remarkable and positive impacts on the farming communities and the general populace.	Support research activities and disseminate knowledge via information and communication technologies to the relevant stakeholders.	Develop acceptable varieties and efficient methods for improving technologies and processing methods.
Knowledge production and management in your institute	Knowledge is produced through participatory approach with the stakeholders and management by all our scientists, through knowledge sharing in both formal and informal fora.		It is goal oriented towards solving specific agricultural problems. The results of research are often disseminated via several media but most especially through extension services.	Efficient.
Knowledge sharing among staff across departments/units	The sharing of knowledge generated is very good and this is taking place through conversations among scientists and using documented sources found in this department.	Through seminars, workshops, monthly meetings with ADPs in south west agro-ecological zone; annual Workshop of Agricultural Research Extension Farmer Input Linkage Services (REFILS); Annual in-house review of programs in the institute.	People generally do not understand the need for sharing knowledge (knowledge exchange). They are selfish about it and often this leads to lack of knowledge by some people. Again, this lack of knowledge exchange impedes communication and knowledge dissemination and documentation by this department.	Moderate.

Themes	Head of Information and Documentations I.A.R. Zaria	Head of Information and Documentations I.A.R. & T. Ibadan	Head of Information and Documentations N.R.C.R.I. Umudike	Head of Information and Documentations N.C.R.I. Badeggi
Methods new staff accessed the experience/knowledge of old staff	Through interaction, information and documentation centre, and departmental reading rooms.	Usually they have been mentored and have participated in different research activities, records of activities and research output in the library.	This is done via training on the job as the newer colleagues are tutored by highly experienced staff.	Direct mentorship and reading from research guides, manuals normally available in this centre.
Knowledge documentation and storage for access	Production of CDs, pamphlets, journals which can be found in this centre.	Yes, in this centre we have output of research results in forms of bulletins, manuals, journal articles, annual reports etc.	Yes, through various publications. However, institutional repositories will guarantee that more knowledge is tapped and stored for future generations' benefit.	Yes, through information and documentation.
Knowledge management policy	No.	No.	Not any one I know presently.	No, but in the pipeline.
Knowledge manager	We only have a librarian as head of information and documentation, and extension personnel serving also as information repositories who interact with farmers.	No, we have librarians, researchers in the area of agricultural extension and network administrators.	Not for now, instead the traditional structure of Director, Information and Documentation is still maintained.	Yes.
Knowledge management department	No.	No, we have library, publication unit and ICT unit.	None for now, maybe in the future as interest continues to grow in the area of knowledge management especially indigenous knowledge management.	Yes.

Themes	Head of Information and Documentations I.A.R. Zaria	Head of Information and Documentations I.A.R. & T. Ibadan	Head of Information and Documentations N.R.C.R.I. Umudike	Head of Information and Documentations N.C.R.I. Badeggi
Knowledge management best practices in the institute		Documents and publication management practices; social networks and interaction.	Not necessarily knowledge management, instead, one can simply opt for information management, especially with reference to the information and documentation department.	Community-based practices targeted at end-users.
Knowledge management infrastructure and its contribution to knowledge management practices in the institute	Library, extension experts, publication unit.	Library, ICT unit, seed store, publication unit, library database and human resources.	The institute generates knowledge, preserves and disseminates same via library practices, information services and extension services.	Information and documentation department.
Knowledge management strategies for enhanced productivity in the institute			I can simply identify the normal training often given to staff generally on information search and use.	Organized seminar/workshop fora; interactive forum/meetings.
Facilities for knowledge management in the institute	Computer networks; experiment laboratories.	Library and ICT laboratories, seed stores.	Library services, extension services and of course the media resources.	ICT centre, database and web management desk.
Knowledge generation and dissemination to stakeholders	Through monthly trainings of stakeholders; annual cropping scheme meetings; journals; newsletters; exhibitions and agricultural shows.	Through seminars; meetings; annual in-house review meetings; interactive sessions with farmers; publication of various research output such as I.A.R.&T. Farmers Guide Series etc.	Via extension services; conferences and seminars; information provision and documentation services; publication and exchange services.	Through seminars, bulletins and annual research review meetings.

APPENDIX 20: Summary of the Missing Values



Variable Summary[a,b]

	Missing		Valid N
	N	Percent	
Other Dept/Unit Worked in Past Five Years	152	71.0%	62
Number of Years in this Dept/Unit	30	14.0%	184
KM Initiatives (Reduction of Costs)	20	9.3%	194
KM Initiatives (Improving Retention of Knowledge)	19	8.9%	195
KM Initiatives (Externalization:turn tacit to explicit)	19	8.9%	195
Age of Respondents	17	7.9%	197
Challenges of KM in the Institutes (Lack of Synergy among Knowledge Management Crew: Knowledge Officers, Knowledge Engineers, and Knowledge Practitioners)	15	7.0%	199
Skills for KM (Processing Factual and Theoretical Knowledge)	15	7.0%	199
Challenges of KM in the Institutes (Inadequate Skills of Knowledge Managers and Workers)	14	6.5%	200

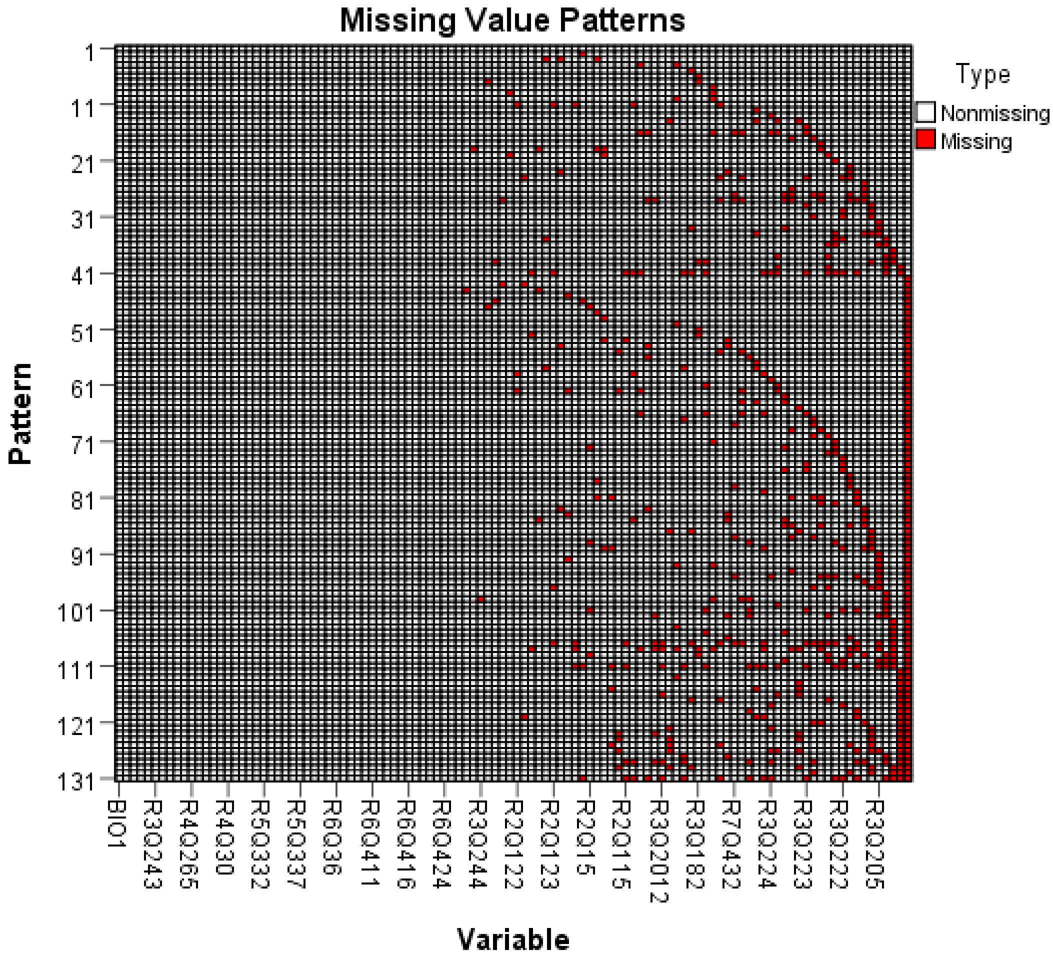
Skills for KM (Finding and Accessing Knowledge)	14	6.5%	200
KM Initiatives (Improving Acquisition or Purchasing of External Knowledge)	14	6.5%	200
KM Initiatives (Changing of the Organizational Culture)	14	6.5%	200
Challenges of KM in the Institutes (Problems with Organizational Culture)	13	6.1%	201
Challenges of KM in the Institutes (Lack of Performance Indicators and Measurable Benefits)	13	6.1%	201
Skills for KM (Ability to Apply Knowledge)	12	5.6%	202
Position/Rank of Respondents	12	5.6%	202
Challenges of KM in the Institutes (Loss of Knowledge from Staff Defection and Retirement)	11	5.1%	203
Challenges of KM in the Institutes (Improper Planning, Coordination and Evaluation)	11	5.1%	203
KM Initiatives (Improving Cooperation and Communication)	11	5.1%	203
Skills for KM (Knowledge Integration and Re-combination)	10	4.7%	204
KM Activities (Knowledge Creation)	10	4.7%	204
KM Strategy Mostly Used (Human Strategy: Social Network and Interaction)	9	4.2%	205
KM Initiatives (Improving Access to Existing Sources of Knowledge)	9	4.2%	205
KM Activities (Knowledge Identification)	9	4.2%	205
Challenges of KM in the Institutes (Inadequate Management Support)	8	3.7%	206
KM Initiatives (Identification of Existing Knowledge)	8	3.7%	206
KM Activities (Knowledge Acquisition)	8	3.7%	206
Comparison (Explicit Knowledge)	8	3.7%	206
KM Initiatives (Improving Training, Education and Networking of Newly Recruited Employees)	7	3.3%	207
KM Best Practices Adopted (Community of Knowledge)	7	3.3%	207

KM Activities (Knowledge Adoption)	7	3.3%	207
KM Activities (Knowledge Organization)	7	3.3%	207
Comparison (Tacit Knowledge)	7	3.3%	207
Educational Status of Respondents	7	3.3%	207
KM Initiatives (Improving Management of Innovation)	6	2.8%	208
KM Initiatives (Improved Documentation of Existing Knowledge)	6	2.8%	208
Activities Lead to Production of Knowledge (Online and Offline Database Search)	6	2.8%	208
Activities Lead to Production of Knowledge (Memos, Reports and Files)	6	2.8%	208
KM Activities (Knowledge Application)	6	2.8%	208
KM Activities (Knowledge Transfer)	6	2.8%	208
Gender of Respondents	6	2.8%	208
KM Strategy Mostly Used (System Strategy: ICT-Based)	5	2.3%	209
KM Resources and Techniques (Storytelling)	5	2.3%	209
KM Resources and Techniques (Cross-Functional Project Teams)	5	2.3%	209
Training, Seminars and Workshops for Capacity Building on KM	5	2.3%	209
KM Initiatives (Improving Distribution of Knowledge)	4	1.9%	210
KM Initiatives (Improving Training and Education of all Employees)	4	1.9%	210
How Often Your Institute Engage in Research and Development Activities	4	1.9%	210
Sharing Information, Ideas, Expertise, and Experience with Colleagues	4	1.9%	210
Activities Lead to Production of Knowledge (Research and Consultancy)	4	1.9%	210
How do you Know about Events in your Institute (Speculations)	3	1.4%	211
KM Resources and Techniques (Mentoring)	3	1.4%	211
KM Best Practices Adopted (Community of Practice)	3	1.4%	211
Number of Training, Seminars and Workshops attended in the Past One Year	3	1.4%	211

Activities Lead to Production of Knowledge (Workshops, Seminars and Conferences)	3	1.4%	211
Category of Staff you Share Knowledge with	2	0.9%	212
Activities Lead to Production of Knowledge (Publications such as Magazines, Newsletters)	2	0.9%	212
Extent of Knowledge Production in the Institutes	2	0.9%	212
Regularity of Knowledge Production in the Institutes	2	0.9%	212
Specialists for KM System in the Institutes (Data Entry Operator)	1	0.5%	213
KM Resources and Techniques (KM Training and Education)	1	0.5%	213
Activities Lead to Production of Knowledge (Interpersonal Discussion)	1	0.5%	213

a. Maximum number of variables shown: 115

b. Minimum percentage of missing values for variable to be included: .0%



Missing Value Patterns
Type
Nonmissing
Missing
Pattern
1
11
21
31
41
51
61
71
81
91
101
111
121
131
Variable
BIO1
R3Q243
R4Q265
R4Q30
R5Q332
R5Q337
R6Q36
R6Q411
R6Q416
R6Q424
R3Q244
R2Q122
R2Q123
R2Q15
R2Q115
R3Q2012
R3Q182
R7Q432
R3Q224
R3Q223
R3Q222
R3Q205