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Integrating Indigenous Agricultural Knowledge into Modern Agricultural Practices for Sustainable Rural Household Food Security in Uganda

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Abstract:
Food security is a major concern of the global development Agenda as reflected in Millennium Development Goals (MDGs) and Sustainable Development Goals (SGDs). Globally 2 billion people are food insecure and the situation is on a rise especially in developing countries. The Modern Agricultural Practices (MAP) being promoted have not solved the situation. The Indigenous Agricultural Knowledge (IAK) that has sustained food production, access and utilization in developing countries is not recognized in food security strategies. Uganda's food security situation is alarming; nearly half of Uganda's 7.3 million households are food insecure. More than 90% of the food produced in Uganda is by peasant farmers and depend on IAK, but there are no formal interventions that seek to encourage people to use it. This study was carried out in Isingiro District, South Western Uganda in the 3 Sub Counties of Masha, Kabingo and Kabuyanda that were purposively selected. Food security is a major challenge facing district and more than 95% of the people struggle to produce food through IAK. The implementation of Millennium Village Project in the district did not change the situation. The study employed a case study research methodology, but priority given to qualitative methods. 102 respondents were interviewed that included; farmers, local leaders and key informants. Three Focus Group Discussions were heldin each sub-county where data collected from. The findings indicated that the district was experiencing both chronic and acute food insecurity. The main causes of food insecurity included poverty, extended dry seasons, lack of granaries and lack of government enforcement. The IAK practices used towards food security included terrain and soil selection, intercropping, weather forecasting, seed selection, sun drying, use of local pesticides and control of banana bacterial wilt. The MAP used included; spraying, planting of hybrid seeds, use of fertilizers, and preservation of beans grains using lindane dust.IAK was contributing greatly towards the four pillars of food security of availability, access, utilization and stability in the district. The study recommends that it should promoted and one way of doing it is integrating it into MAP since it is what the majority use.Regarding integration of IAK and MAP, the study revealed that there was a conscious integration of both and came up with a six step frame work that can be applied to integrate IAK into MAP to ensure sustainable food security at rural house hold level in Uganda.

Keywords: *Food security, indigenous agricultural knowledge, modern agricultural practices*

1. Background to the Study

Food security is an essential part of the international development agenda, as stated in the Rome Declaration of the World Food Summit in 1996 and re-affirmed by the participants in the World Food Summit five years later (FAO,1996 & FAO, 2001). The Millennium Declaration reflected the World Food Summit target by making hunger part of the first Millennium Development Goal (UN, 2009). UN has echoed food security once again by making it Goal number 2 of the 17 Post 2015 Sustainable Development Goals (SDG) at the Rio+20 conference (UN, 2014). Food security is a fundamental human right (UN, 1997) and the most crucial of all basic needs (UN, 2009). It is upon this that 16th October every year is World Food Day and the World Food Day theme for 2014 was Family Farming: "Feeding the world, caring for the earth" (FAO, 2014).This shows how food security continues to be a major global challenge and the need to address it especially in Sub Saharan Africa where the levels of food production are declining. The 2017 theme focused on investment in food security and rural development (FAO, 2017). Emphasis was put on combined strategies and application of indigenous knowledge being one the strategies. Any investment towards food security and rural development without considering IAK is likely to fail as (Brokensha, Slikkerveer, & Warren, 1995)put that ignoring people's knowledge is almost to ensure failure in development.

Globally 2 billion people lack food security; about 1 billion people are hungry at any time in the world and of these 254 million people are found in Sub Saharan Africa (FAO, 2012; Moore , Clapp, & Timoty, 2013; IFPRI, 2016). Six million children die of hunger every year and 17,000 every day (Gibson , 2012; FAO, 2012; FAO, 2014).In addition, according to International Fund for Agricultural Development (IFAD) Poverty Report (2012), developing countries are urged to double

food production to avert food insecurity. (FAO, 2012) further warns that sub-Saharan Africa will be hardest hit by food insecurity, since it is where most vulnerable groups are found and yet its grain yields are the lowest in the world (Action Aid Uganda, 2016).

The modern agricultural practices for food security being promoted such as Genetically Modified (GM) crops, seeds and cereals have not solved the situation in developing countries where more than 90% of food production is by small scale farmers especially women using IAK (UN Millennium Project, 2005a; FAO, 2012; FAO 2016; UNEP & IISD, 2013 & Abiola et al., 2011).

The dawn of agriculture and food security in particular occurred independently in many parts of the world around 10,000 years ago, through the use of Indigenous Agricultural Knowledge (Mulvany, 2001). Globally, indigenous knowledge, particularly agricultural and environmental indigenous knowledge systems, gained international recognition after the United Nations Conference on Environment and Development (UNCED) held in June 1992 in Rio de Janeiro and Rio+20 (UN, 2014). Agenda 21, one of the environmental agreements signed, emphasizes that governments and intergovernmental organizations should respect, record, and work towards incorporating indigenous knowledge systems into research and development programs for the conservation of biodiversity and sustainability of agricultural and natural resource management systems. However, there is no clearly developed framework demonstrating how the two can be integrated especially in food production. This argument is further supported by The 1st African Food Security and Adaptation Conference held in August 2013 at the UN headquarters in Africa in Nairobi, Kenya (FAO, 2012; IISD & UNEP, 2013). This is because Indigenous knowledge is an important part of the lives of the rural poor for it is their basis for decision- making in areas of agricultural production, food security and natural resource management (Gliessman , 1998; Kassie et al., 2012; Makoni & Jennifer, 2005).

Globally, there are two distinct knowledge systems; the knowledge systems of formal sector / Western / Modern Knowledge of both private and public institutions, and the knowledge systems
of the informal sector of communities and individuals which is Indigenous Knowledge (IK) (Mulvany, 2001). The difference between the two is that the former is open, codified, recorded in writing, analytical, advancing on prior achievements and defended through national and international law. On the other hand, indigenous knowledge system is a systematic body of knowledge acquired by local people through accumulation of experiences, informal experiments and intimate understanding of the environment in a given culture (World Bank , 2008; Nakashima, 2010). It is orally transmitted, built on trust and defended through the norms and practices of a particular society. It is closed, holistic rather than analytical, and proceeds on the basis of new experiences, rather than on the basis of a deductive logic.

The advent of colonization followed by neocolonialism and globalization, which emphasize modern science and technology, have led to this form of knowledge being negated and ignored altogether in sustainable development strategies; food security inclusive. According to Battiste, (2002) & Srikantaiah, (2008), Eurocentric scholars have often dismissed indigenous knowledge in the same way they dismissed any socio- political or cultural aspect they did not understand. They have taken three main approaches to indigenous knowledge; reduced it to taxonomic categories that are static over time, reduced it to its quantifiably observable elements, and lastly assumed that Indigenous Knowledge has no validity except in the 'spiritual' realm. None of these approaches adequately explains the holistic nature of indigenous knowledge and its fundamental importance to people in developing countries as it's their way of life unlike modern science, which is knowledge about how to live and is thus completely ignored. In Eurocentric thought, indigenous knowledge is often conveniently represented as 'traditional knowledge', connoting a body of relatively old information that has been handed down from generation to generation essentially unchanged, hence dismissed as obsolete yet in Europe, China, India, and Japan, indigenous knowledge has been developed into modern knowledge (Marsden & Morley, 2014).The question of validity of indigenous knowledge is answered by presence of people who use it and have relied on it for centuries for survival and development. According to (Helmore & Singh , 2001) and (IISD & UNEP, 2013), 50 percent of the world's population depend on IAK for crop production and food supplies but its application towards sustainable development strategies and sustainable food security in particular remains elusive.

In 1996, the World Bank articulated the vision to become "a knowledge Bank". This was endorsed at the Global Knowledge Conference in Toronto, Canada in 1997 by political leaders and civil society representatives from developing countries (World Bank , 2008). This resulted into the formulation of the World Bank's Indigenous Knowledge framework for mainstreaming and integrating indigenous knowledge in the development process. Projects where indigenous knowledge was used in organic farming and cultivating medicinal plants included Karnataka project which helped to start community exchanges to other watershed projects with in India and Sri Lanka. One hundred seventy-eight of the integration fund supported projects eventually created free-standing projects on indigenous knowledge (Gorjestani, N, 2005) and helped in institutionalizing indigenous knowledge into national development policies (Srikantaiah, 2008). All this shows the importance of IK but its documentation, mainstreaming and integration in food production remains a challenge amidst the preferred modern agricultural practices. It should however be noted that 70% of the food production in the world is by small scale farmers who use IAK in food production processes (FAO, 2014).

According to UNESCO, (2006); Srikantaiah, (2008)& Lwoga, (2008) , local communities have relied on their IK and expertise for centuries to cope with the challenges posed by harsh environments, prolonged drought, floods, pests and infertile soils. Farmers had developed their own systems of weather forecast by observing cloud formation; bird migration patterns, seasonal winds and seasonal factors, or worked out complex sustainable land use systems. In this case, IK has evolved into a science and technology of its own, with farmers and communities performing as scientists and innovators observing, drawing conclusions and taking action. Unfortunately, the introduction modern agricultural practices greatly affected the use of IK in the name of modernization.

Amidst the threat of modernization, IK innovations have enhanced livelihoods in a manner that is ecologically sustainable, economically viable, socially acceptable and significant. Indigenous agricultural knowledge has contributed to the four most important factors in food security: availability, access, utilization and frame work conditions such as food emergency preparations and physical health of consumers and producers (World Bank , 2008). The benefits of modern agriculture practices and the Green Revolution are undisputable; however, there is evidence that in the event of severe shortages of most staples, many communities in Africa revert, as a survival mechanism, to indigenous plants and ways of production that are not recognized in modern agricultural practices thus the need for validation and integration IAK into MAP for sustainable food security at household level in rural areas. The integration of IAK in food production would thus be important for any program focused on improving the world food systems.

In Peru, archeologists have discovered simple, effective agricultural techniques used in large areas of Peru 3000 years ago, that can outperform modern agricultural technologies under circumstances found throughout much of the Third World today (Waithaka , 2011). The old-new techniques, known as "raised-field agriculture", are simple, cheap; require little more than human labour and no chemical fertilizer or modern machinery. According to (Rajasekaran, B, 1993) they have out-yielded conventional, capital-intensive fields as producers of potatoes, one of the region's main crops both in Pre-Colombian days and now. When conventional fields die in a drought or flood, the raised-fields mostly survive. This further supports the need to integrate IAK best practices into modern agricultural practices for sustainable food security.

In Nigeria, over the last two decades, there has been a dramatic increased interest in the role that indigenous knowledge can play in participatory approaches to food security and sustainable development (Abiola et al., 2011). Recent research has given valuable insights into how people use their own locally generated knowledge to change and improve their livelihoods. Farmers, most of whom are women, adopt a wide range of indigenous agricultural practices based on informal experiments, experience and intimate understanding of their environments. The application of indigenous agricultural knowledge to food production and availability is reflected in the following: indigenous soil preparation and planting materials, indigenous methods of controlling pests and diseases, indigenous methods of maintaining soil fertility, indigenous methods of controlling weeds and indigenous methods of harvesting and storage. All these show that IAK is a significant resource towards the attainment of food security in rural areas hence the need to integrate it into modern food security strategies rather than leaving it to be marginalized as traditional.

Agriculture is the backbone of Less Developed Countries (LDCs). It is the core for food production, economic growth and poverty alleviation. In Uganda, agriculture is the most important sector of the economy; 86% of the population depend on it as their source of livelihood. Agriculture accounts for 75.1% of employment, 23.7% of Gross Domestic Product (GDP) and 47% of the total exports (National Development Plan 11, MFPED, 2015). Remarkably more than 90% of agriculture is in the hands of peasants especially women who depend on indigenous agricultural knowledge which is not acknowledged (Aluma J. , 2004 ; National Development Plan 1, MFPED, 2010& National Development Plan 11, MFPED, 2015).

In Uganda, a number of IAK for food security do exist and has enabled production of food crops for a long period of time. According to (Critchley & Marit , 2003) building on local knowledge brings success. Critchley and group introduced graded terraces in Kamwezi in Kabale District using instructions;like all top-down programmes, failures were more common. They never realized that the area was a very densely populated in which people could not be expected to leave wide uncultivated strips between their plots of land, which would be total wastage of land. The farmers had their indigenous way of terraces that they have applied up to the present day.Thus, understanding and incorporating indigenous agricultural knowledge of communities substantially reduce the risk of failures of development projects. Unfortunately, this knowledge is not recognized in agricultural extension approaches hence the argument for its integration into household food production strategies for sustainable physical, social and economic access to safe, nutritious and culturally acceptable food at household level in rural areas.

Since independence, Uganda has been implementing modern agricultural practices to solve the food security challenge. These are Extension through Progressive Farmers (1956-1963), Extension Educational Methods (1964-1971), The Project Approach (1981-1991), The Unified Extension Approach (1992-1998), National Agriculture Advisory Services (MAAIF, 2001) and Operation Wealth Creation; The New NAADS model (ACODE 2015) in 2014. The above approaches have scored little or no success at all and have always been abandoned (Ssemakula et al., 2006; Okoboi et al., 2013; ACODE, 2015& Action Aid Uganda, 2016). The above approaches focused on homogenous sectorial implementation strategies, neglected endogenous local assets and unexploited territorial potential of indigenous agricultural knowledge. An approach that would have advocated for integrating IAK into MAP could have possibly made approaches effective since it is what most farmers use in food production. More than 90% of the food produced in Uganda is by peasant farmers especially women who depend on IAK, but there are no formal interventions that seek to encourage people to use IAK to improve the food production (Semana A. , 2002; National Development Plan 1, MFPED, 2010; National Development Plan 11, 2015; Sebaggala & Matovu, 2013). In addition, there are no known studies that have been conducted on integrating IAK into MAP in an effort to ensure sustainable rural household food security in Uganda. Studies by (Aluma , Akwang , & Mwesigwa , 2001) centered on Integrating Indigenous Knowledge (IK) in Agricultural Research. Muwanga (2005) looked at Integrating Knowledge (IK) into Uganda's Poverty Eradication Action Plan. Others studies centered mainly on documentations and dissemination such as Akullo et al., (2007); Humba (2015); Tabuti & Van Damme (2012); Kaddu & Hamba (2016).

1.1. Statement of the Problem

Uganda's food security situation remains alarming; nearly half of Uganda's 7.3 million households are food insecure (Ssewanyana & Kasirye 2010; WFP, 2015; OPM, 2017; IPC, 2017 & IPC, 2018).More than 4 million Ugandans are

severely food insecure, 35-45% of children are stunted and most Ugandans are undernourished (FAO, 2016 & MAAIF, 2016). More than 30% of Ugandans are currently experiencing a cute food insecurity; a situation that might lead to death (FAO, 2016).

Uganda has been implementing modern agricultural extension approaches aiming at improving agriculture production and food security. These include Extension Educational Methods (1964-1971), The Project Approach (1981-1991), The Unified Extension Approach (1992-1998). National Agriculture Advisory Services (NAADS) (MAAIF, 2016) and Operation Wealth Creation (ACODE, 2015). The impact of these approaches has been minimal; if any and have always been abandoned (Ssemakula et al., 2006 ; Okoboi et al., 2013; ACODE, 2015 Action Aid Uganda, 2016) and attaining food security has continued to be a major challenge in Uganda (WFP, 2015; FAO, 2016 & MAAIF, 2016; OPM, 2017; Fews Net/ IPC 2018). More than 90% of the food produced in Uganda is by peasant farmers who depend on IAK, but there are no formal interventions that seek to encourage people to use it to improve the food production (Semana, 2002; National Development Plan 1, MFPED, 2010; Sebaggala & Matovu, 2013 & National Development Plan 11, 2015).

Food security is a major challenge facing Isingiro District (Siriri, 2007; Sachs 2005 & 2010; ACORD 2010; OPM 2017; IPC 2017; GoU,UNHCR,UNICEF, WFP, 2017 & Isingiro District LGDP11 2015/2016 - 2019/2020) despite the implementation MAP by government such as use of hybrid seeds, plants, artificial fertilizers, herbicides, pesticides and use of tractors. More than 95% of the people struggle to produce food through indigenous agriculture knowledge (Isingiro District LGDP11 2015/2016 - 2019/2020). MAP and IAK have almost run as parallel practices with IAK largely practiced by the majority of the people who are largely poor and MAP by the middle or well-off who constitute the minority; though, they don't use it entirely. The implementation of Millennium Village Project in Isingiro did not change the situation. Despite the strength of IAK and MAP towards sustaining rural household food security, there is no strategy developed on how the two can be integrated to enhance food production. Hence a sustainable rural household food security strategy in Uganda could better be served by a system that integrates both IAK and MAP.

1.2. Goal of the Study

The goal of the study was to explore how indigenous agricultural knowledge and modern agricultural practices can be integrated in food production systems for sustainability of food security in Uganda

1.3. Specific Objectives

- Ascertain the nature of the food security situation in Isingiro District.
- Establish the existing practices of indigenous agricultural knowledge used in food security despite the popularization of MAP by government in Isingiro District.
- Examine the existing practices of modern agricultural practices used in food security in Isingiro District
- To establish if there is any integration of indigenous agricultural knowledge and modern agricultural practices in food security in Isingiro District

2. Methodology

The study was carried out in Isingiro District in the 3 Sub Counties of Masha, Kabingo and Kabuyanda that were purposively selected because of their uniqueness on the basis of agricultural activities carried out in the area and location. Kabingo Sub County is predominantly dominated by crop farmers, it is a major crop producing Sub County in the district and it is surrounded by other seven sub counties that are predominantly dominated by crop farmers. Masha Sub County is dominated by mixed farmers and it is a sub county where there are more farmers that use a tractor in cultivation. Kabuyanda Sub County was the first sub county where Ruhiira Millennium Project was established. The study employed a case study research methodology adopting a mixed methods approach where both qualitative and quantitative methods were used but priority was given to qualitative methods. The quantitative methods were only used in generation of simple descriptive statistics. The sample size where greater emphasis is placed on qualitative methods follows the concept of saturation (Glaser & Strauss, 1967). Most qualitative research scholars agree that the point of saturation is usually reached towards 30 interviews and 15 interviews is the smallest acceptable sample (Mason, 2010; Creswell, 1998; Bertaux, 1981; Ritchie, Lewis, & Elam, 2003; Teeter & Sandberg, 2016).

Simple random, systematic and purposive sampling methods were used in selecting the respondents to participate in the study. Simple random sampling without replacement, was used to get the parishes where the study was conducted. Systematic sampling was used to get the households (farmers) to be considered in the study. This is the sampling method in which the K^{th} element of the sampling frame is selected; which gives a sampling interval (Amin, 2005; Mugenda and Mugenda, 2003). A sampling frame was constructed using each parish register and the number of households in the parish would be divided by 6 to get the size of each interval in order to get the household to consider in the study after randomly selecting the first one. Thirty to thirty-one households were selected from the 3 sub counties which gave a total of 91 households (respondents).Purposive sampling was used to select local leaders, community development officers, agricultural extension workers, operation wealth creation officers and participants in FGDs. 102 respondents interviewed who include; farmers, local leaders and key informants and held three focus group discussions each in the sub-county where data collected from. The methods used in data collection included; interview, FGDs, observation, and analysis of documents; thus, ensuring the principle of triangulation.

3. Indigenous Agricultural Knowledge and Food Security

The basic component of any country knowledge system is its indigenous knowledge, which encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood (Ellen and Harris 1996 & World Bank 2009).

The respondents revealed the following IAK practices that they use in food production.

IAK Practice	*Frequency	%
Use of hoe and panga	102	100
Ploughing, weeding and pruning for proper growth	102	100
Putting cow dung manure where you have ploughed	53	60.0
Putting compost manure where you have ploughed	51	50.0
Forecasting beginning of the rainy season	72	70.6
Rotational bush fallowing	61	59.8
Crop rotation	93	91.2
Terrain and soil selection	82	80.4
Harvesting of millet by women groups	31	30.4
Inter cropping	86	84.3
Seed selection	87	85.3
Informal cultivation groups	31	30.4

Table 1: Showing IAK Practices Used In Food Production in Isingiro District
Source: Field Data 2017
** Multiple Responses*

3.1. IAK Practices Used in Food Production in Isingiro District

3.1.1. Ploughing, Weeding and Pruning

Ploughing, weeding and pruning were mentioned by all the respondents 102 (100%). Ploughing or tilling of land involved two aspects. One aspect involved ploughing when burying weeds or bush when the area has been under fallow. The practice is very important in that it adds green manure to the soil. This was usually done when preparing a garden for planting of sweat potatoes, Irish potatoes, maize, beans and cassava. Another aspect of ploughing was that one where there was no burying of husks of maize and millet, weeds or opening a new area. The husks, weeds or grass were cut into small pieces; mixed into the soil and decompose adding manure to the soil. These two aspects of ploughing are important for adding green manure to the soil and other soil nutrients that are important for proper growth of plants. The above findings are in agreement with Akullo et al., (2007) who stated that the indigenous knowledge of the people is very effective in meeting their food requirements, effective in areas of soil enrichment, land clearing, sowing, harvesting, weeding and mound/ridge making. She further states that their mixed farming, mixed cropping, crop rotation and shifting cultivation helps tremendously in their bumper harvest. Furthermore, Nyota and Mapara (2008) & Lwoga et al., (2010). Assert that this knowledge spans from clearing the land, tilling, selecting seed varieties for planting, planting, harvesting and storage and identifying weather patterns

3.1.2. Weeding

Weeding was carried out at different stages of plant growth and depended on the type of crop. This was an important activity in that the weeds are removed from plants which ensured proper growth of plants as weeds compete with plants for soil nutrients. Weeding was being carried out by use of hoe and hands in case of maize, beans and cassava. The hoes that were being used are old hoes which cannot cut deep in the soil to cut the roots of plants and even the kind of digging was made in such a way that little soil was just removed without cutting plant roots. According to Hager (2015), weeds have many attributes undesirable to crop producers that reduce crop yields through competition for resources such as sunlight, water, nutrients, and space. Weeds also may harbor insects and provide a host for certain plant pathogens. All this shows that farmers indigenous knowledge is important as scientific knowledge.

Weeding of sweet potatoes and Irish potatoes involved the pulling of weeds using hands with digging stick or metal about 2 feet long pointed at one end. This helps to ensure that the root tubers are not damaged and in pulling the soil back to the plant. The weeding of bananas involved the pulling of weeds using hands; with the help of a pang, a very old hoe or a chisel like flat shaped tool. This is discussed in detail under IAK used in Banana production in Isingiro District. The findings are in agreement with Mandumbu et al., (2011) who discussed integrated weed management in Zimbabwe and identified various practices that indigenous people undertake during weeding. These practices include hand-hoe weeding, intercropping, heaping manures, tillage, early planting, crop rotations and animal drawn implements.

3.1.3. Pruning

Pruning is the removal of unwanted plants from the garden or parts of the plant. Pruning was mainly done in maize, cassava, banana plantations and in some cases on beans. This helped to reduce the number of plants so that there is no competition for light and soil nutrients. This enhanced the growth of the plants leading to good yields.

3.1.4. Forecasting the Beginning of the Rainy Season

Agriculture in Uganda is rain fed Leliveld, et al., (2013), therefore determining the onset of rains is an important IAK aspect. Forecasting the beginning of the rainy season was mentioned by 72 out 102 (70.6%) of the respondents. This involved aspect of weather projection and hence the planting season. The following signs determined that rains were about to start; wind direction, it was found out during the study that when the wind brows towards the east (where the sun rises), it indicated the beginning of the rain season and when the windows blow towards the west and south west then there is no rainfall. During the study I, observed that even in the rainy season the rain falls after the wind has blown to the east and even if the signs of rain were high and the wind blows to the west and southwest it would not rain.

The appearance of whirlwinds; these are winds that blow lifting light materials from the earth surface such dust, pieces of papers, leaves and dry grasses into the sky. It was found that they signify approaching rain. Asked why they believe in the Whirl winds as a sign of the approaching rain season the respondents revealed that the dust taken up in the sky helps to stop the winds bearing rain fall to continue and the rain falls.

Cloud formations in the sky was another sign of the beginning of the rain season or rain. The respondents revealed that the formation of heavy white clouds in the sky symbolize the start of rainfall. The white clouds eventually turn blackish leading to rainfall.

Experiencing of unusual intense warmth / high temperatures during the day and night was also another sign for the start of a rainfall season. The temperature changes, from relatively high temperatures during day to intense warmth especially at night.

The flowering of plants such as mangoes, thickets and shrubs symbolized that rains are about to begin and the falling down of flowers is accompanied by the start of rainfall.

The appearance of red ants on the ground; also symbolized the beginning of the rainy season. The respondents revealed that during the onset of rains there is intense warmth in the air and this heat is also experienced with in the ground which forces the ants to move out of their colonies to other areas that may have less heat especially near the earth surface.

In relation to above findings, FAO (2009) established that many rural communities have vast knowledge of previous variations in climate and weather and have developed mitigation and adaptation strategies for ensuring food security. Communities apply traditional knowledge in early warning systems that calculate risks or detect extreme weather events, droughts or floods. They use it in adapting subsistence strategies for agriculture, fishing, forestry and foraging; improving water and resource management; enhancing ecosystems; selecting which resources to use to mitigate or adapt to climate change effects. According to Nyong, et al., (2007), Indigenous knowledge has the potential of providing information for addressing current and future climatic events and building on indigenous knowledge system offer great prospect for effective integration strategies to small-scale farmers.

Egeru, (2011) adds that natives in Soroti District have particular indigenous knowledge systems to foresee and cope with such challenges such as floods, droughts, diseases and pest and disease infestations. The transfer of this knowledge and associated practices has been embedded in the culture through various rites of passage such as birth, initiation into adulthood, marriage, death, twin dancing and social gatherings that include beer parties.

3.1.5. Soil Selection

Soil selection was mentioned by 82 out of 102 (80.4%). The respondents revealed that understanding the type of the soil and the crops that grow well there was important for crop growth. In addition to the soil types various terrains were important for the growth of various crops. It was mentioned that low lands were ideal for growth of maize, beans, Irish potatoes, groundnuts, sweat potatoes. The soil in these areas are usually alluvial loam soils or loam soils that are ideal for growth of plants. Banana plantations were found to be growing well on gentle hill slopes and on flat topped hills were the water was draining gently. Onions and pineapples were found to be doing well of slopes of gentle hills with sandy soils.

3.1.6. Inter-Cropping

Inter-cropping was another, IAK practice that was mentioned by 86 out of 102 (84.3%) of respondents. This involved the growing of more than 2 crops on the same piece of land. Through observation I, found out the following patterns of intercropping: maize, beans and cassava, beans and maize, cassava and sweat potatoes, bananas and beans; groundnuts and maize and millet and maize. The idea behind inter-cropping was “not putting your eggs in one basket”. The respondents revealed when 2 crops are grown together you are assured that in case one does not do well there other one will do. In addition; due to the scarcity of land; inter-cropping enables a homestead to have a variety of food crops hence ensuring food availability, stability and utilization. In support of the above, (Domfeh (2007) & Mwaura (2008) pointed out that to manage the lands on which these important crops are planted, indigenous practices such as mixed cropping which preserves the fertility of soil to ensure availability of food, and minimal tillage which keeps top soil strong enough so as not to be washed away by flood water, are used by the local African people. Mixed cropping systems allows for the planting of various types of crops in a particular portion of land – for example, planting maize with beans. Such symbiotic relationship increases the fertility of soil through nitrogen fixation and helps control weeds. It is also important to note that such an indigenous practice reduces the likelihood of the occurrence of famine that may result from the failure of one particular kind of crop due to diseases or other hazards – there would be a replacement crop available for consumption (Mwaura, 2008).

3.1.7 Rotational Bush Fallowing

Rotational bush furrowing was mentioned by 41 out 102 (40.2%). This involved rotating crops with bush; which allows the soil to rest and gain fertility. This practice was being practiced by very few people in the district in that many people have small land holdings and leaving land under bush fallowing is becoming hard for them due to population increase and land fragmentation. This practice was being carried out by those had relatively big land of about 4 - 5 acres and above.

3.1.8. Crop Rotation

Crop rotation was mentioned by 93 out 102 (91.2%). This involved growing different crops on the same piece of land season after season. The reasons given was that different crops consume different nutrients from the soil while others add their nutrients. The above is in agreement with Adelowo (2003) who asserts that farmers rely on crop rotation to rejuvenate the soil whereby many farmers in tobacco growing areas prefer planting root crops in plots that originally had tobacco to control pests among other advantages, which consequently improves food security through better yields.

3.1.9. Seed Selection

Seed selection was mentioned by 97 out 102 (95.1%). This involved identifying best crops and choosing the best seeds among those harvested through observation and sorting. Seed selection was applied to all crops grown in the district. These crops were maize, beans, peas, millet, sorghum, Irish potatoes, cassava, sweat potatoes and bananas. This enabled the planting of good seeds that lead to good yields. It was found out during the study that if one harvested poor grain she would go to the market and buy good seeds or get them from a friend. Relatedly, Tjiek (2006) emphasized that smallholder farmers still want to apply their indigenous methods and technology in farming, particularly in using their own traditional seeds suitable to their climatic conditions without application of chemicals, which are deemed hazardous to the environment and consumers. Such seeds are locally preserved and have drought tolerance and pest resistance. They also have a superior taste and are highly accepted by the local communities. The scientific basis of many of the indigenous technologies can indeed provide new ways of solving contemporary problems including enhancing food security.

According to Akullo, et al., (2007) farmers also practice selection of clean planting materials to control pests and diseases as in the case of formal research whereas for cassava, they ensure that the cuttings are not damaged prior to planting and that nodes face downwards to encourage effective sprouting and root growth. It is also believed that in southern Sudan for example, women are directly responsible for selection of all sorghum seeds saved for planting each year. They cull seeds and preserve a spread of variety of conditions that may arise in any given growing season (Easton & Ronald, 2000). In northern India, an elderly woman farmer puts the matter succinctly as she selects seeds for storage; it takes a sharp eye, a sensitive hand and a lot of patience to tell difference between the seeds. But these are not the things that are honored any more (Easton & Ronald, 2000).

3.1.10. Harvesting of Millet by Women Groups

Harvesting of millet by women groups was mentioned by 62 out 102 (60.8%). This involved women in a particular location in a village mobilizing themselves to start harvesting millet. Millet ripens almost at the same time; and it is attacked by birds and when it over ripens the millet grain start to fall off to the ground resulting into a loss. This requires quick harvesting hence the need to pool labour. The women harvest in groups of 5-10 women especially those from the same locality with in the village. The whole day is spent at one garden harvesting and if not finished they would come another day until the garden is finished and they continue working together in turns until they finish all gardens for women in a particular group and then the group is abandoned until the next harvesting season. The respondents further revealed that in the next harvesting season, women may not necessarily be in the same group, others may join other groups while others may decide to form another group depending on the need. During harvesting the host home ensures that there is plenty of millet porridge for refreshment and food. This is a type of social capital which is embedded and dependent on community need. Woolock (1998 & 2001) distinguishes three types of social capital modes: bonding, bridging and linking networks. This type of social capital would be both a bond and a bridge as women possess the same type of resources, they come from the same village; but it is also a bridge as it helps them access labour as a resource which they would not have. In terms of IAK, the way people mobilize themselves to work together especially since they have no access mechanization is important for the success of agriculture. In places where communities are poor like Isingiro, mechanization may not work.

3.1.11. Informal Permanent Cultivation Groups

Informal permanent cultivation groups were mention by 31 out 102 (30.4). This kind of arrangement was only found in Kabuyanda Sub County. The groups were doing cultivation, weeding and harvesting together. This explained in detail in section: MVP and food security in Kabuyanda Sub County.

3.1.11.1. Application of Manure to Gardens

Application of manure to gardens was mentioned by 53 out of 102 (52%). The manure applied ranged from cow dung, goat dung and composite manure. It was revealed during the study that most people were applying composite manure and goat dung which were easy to get and to apply to gardens and plantations. The application of cow dung was mainly done by the relatively rich people in the district, because it was expensive; by the time of the study a small tipper lorry of cow dung costed between 60,000 – 80,000/= without transport however those with cows were finding it easy to

apply it. Though it required labour to collect it from the where the cows are staying to a place near or within the banana plantation, to dig gutters near the banana mat where to put it and later cover it.

3.1.12. Mulching

Mulching was mentioned by 68 out 102 (66.7%). This mainly involved the use of elephant grass, and to mulch the gardens. During the study, it was found out that most gardens that were being mulched included those of crops such as tomatoes, cabbages and pineapples. As regards mulching of banana plantations; it mentioned by all the respondents. Mulching conserves water in the soil, control weeds and soil erosion which is important for plant growth.

3.2. Indigenous Agricultural Knowledge Practices for Food Preservation.

Food preservation is an important aspect of food security and without it, the attainment of food security components would be hard to attain.

IAK Practices Used for Food Preservation	*Frequency	%
Sun drying	102	100
Leaving millet and maize in husks	46	45.1
Use of local pesticides	38	37.3
Use of wood ash	42	41.2
Use of cow dung ash	54	53.0
Use of banana juice	36	35.3
Burning sorghum with banana leaves	17	16.7
Spreading Irish potatoes on the ground	43	42.2
Deeping a sack in diluted ambush	09	8.8

Table 2: Showing IAK Practices Used for Preservation
Source: Field Data 2017
**Multiple Responses*

3.2.1. Sun Drying

According to the table above, sun drying was mentioned by all the 102 (100%) respondents. It involved spreading the harvests on an open ground or tumpline where they are exposed to the sun every day until they properly dry. Sun drying was applied to the following crops cassava, maize, beans, millet, sweat potatoes, sorghum and matooke. It was after sun drying that other practices of preservation were applied such as pesticides and ash. According to Ibnouf (2011), women are key innovators, developing new ways to secure food supplies. Women in the rural western Sudan have developed a new food source from watermelon (Citrullus lanatus) by drying and then grinding watermelon seeds and using these dried seeds to make a porridge (called locally bajbaji), dried watermelon seeds can be preserved for years. Relatedly, in a study carried out in Uganda by Agea et al (2008) revealed that as many as 95% of respondents still used sun drying as the major indigenous practice for food processing. While a survey carried out by Nnadi, et al (2013) in Anambra state of Nigeria, showed that more than 80% of the respondents still used sun drying for food preservation. According to Asogwa, et al., (2017), sun drying is a key traditional and inexpensive method of food preservation because of its versatile application to numerous foods and almost all food items can be sun dried such as tubers, cereals, vegetables and fruits.

3.2.2. Leaving Millet and Maize in Husks

Leaving millet and maize in husks was mentioned by 46 out of 102 (45.1%) respondents. The respondents revealed that leaving maize in husks when properly sundried can last for more than one year while millet can last for more than 3 years. It was further revealed that if continuously sun dried after like every six months millet can last longer than 5 years. It was further revealed that it is important to continue checking to ensure that there are no termites, rodents or any roof leakage that may bring in water in the millet or maize.

3.2.3. Application of Local Pesticides

Application of local pesticides such Cyprus tree leaves, red paper bellies, Mexican Marigold leaves and Neem tree leaves were among the local pesticides used in preservation of beans. The use of Cyprus leaves was mentioned by 38 out of 102 (37.3%) respondents. The Cyprus tree leaves have a unique smell that when put in beans; the smell repels bean weevils from attaching the grains. Through observation Cyprus trees could be seen grown in many compounds in Masha and Kabingo Sub Counties.

Putting red paper bellies in beans was mentioned by 19 out of 102 (18.6%) respondents. Red paper bellies are picked and crushed in water then mixed with beans and sun dried. It was revealed that the smell and the sourness stop the bean weevils from attacking the beans. The challenge with application of red paper bellies was that it inches the body and its smell is too much; now that some people keep their harvest in houses where they live. This explains why few people mentioned to be applying it. In agreement with the above, Mihale, et al., (2009) on a general observation revealed that smallholder farmers revert to indigenous ways of pest management as pesticides are not readily available and financially accessible

Application of Mexican Marigold leaves was mentioned by 16 out of 102 (15.7%) respondents. Mexican Marigold is a shrub-weed that mainly grows in fallow. The respondents revealed that its leaves repel the bean weevils. The leaves of Mexican Marigold are collected and put in dry beans and weevils will not attack them. Relatedly, in a study carried out by (Agea, et al., 2008 in Uganda showed that majority (77%) of the households reported to be using locally made pesticides such as red pepper, banana juice, wood ash, citrus lemon leaves, neem tree, tobacco and tephrosia leaves to control an array of pests such as maize stem borers and cabbage diamondback moths that destroy food crops while in the gardens and those such as rodents and bean weevils (bruchids) that destroy foods in storage. Only about 5% of households interviewed depended on synthetic pesticides. Modern synthetic pesticides were said to be costly to buy thus its low use by the farmers.

Use of wood ash was mentioned by 42 out of 102 (41.2%) respondents. Wood ash is got from the cooking places such as kitchen. Wood ash is mixed with beans that have been sun dried as the weevils would not attack them. Relatedly, Asogwa, et al., (2017), found out that use of ash for grain preservation has a long history in the Bar-Sauri, Kenya and continues to be popular with the farmers. Apart from the use of sneeze wood, the farmers also use leaves from some trees which have been known to have medicinal values. The leaves are burnt and the powder used to preserve the grains. This indicates that ash is a cheap, cost effective and a resourceful component in grain preservation; a practice that can be enhanced by modern science.

Cow dung ash was mentioned by 54 out of 102 (53%) respondents. The dried cow dung is burnt to ash; the ash is left to cool down and the unburnt, soil particles, stones and sticks are removed from the ash. The clean and smooth ash is then mixed with beans. Like the wood ash; the respondents revealed that the ash stops the weevils from attacking the beans. A number of IKPs in pest management have been recorded and studies have recommended the use of indigenous pest management strategies as viable and ecologically friendly options (Gressel, 2010; Farooq, et al., 2011 & Zijlstra, et al., 2011). According to Abate, et al., (2000) these indigenous knowledge pest management strategies are based on “built-in features in cropping systems, such as farm plot location, crop rotation, and intercropping, or on specific responsive actions to reduce pest attack, such as timing of weeding, use of plants with repellent or insecticide action, traps, scarecrows, smoke, and digging up grasshopper egg masses”.

Another ash that the respondents revealed was burnt bricks ash; being mentioned by 09 out of 102 (8.8%) respondents. The burnt bricks are crushed or pounded to ash and the ash is then mixed in beans. Like other ashes, it was mentioned that it stops bean weevils from attacking the beans. This was revealed during a focus group discussion in Kabingo Sub-county. Relatedly farmers in Zimbabwe hailed traditional methods of treating and preserving seeds and grain for consumption. They argued that these were affordable and reliable. MaDube from Plumtree (Madlambudzi area) revealed that dried maize cobs and manure are burnt with gum tree leaves, mtshwili/ mudzweri tree or a thorny and milky type of tree (umhlonhlo) into ashes. The ash mixture is used to treat sorghum, millet, maize, rapoko and the granary in which the grain will be stored (Matsa & Mukoni, 2013).

The use of banana juice was mentioned by 36 out 102 (35.3%) respondents. The concentrated banana juice is mixed with beans and then sun dried. The thick layer of juice dried on the grains does not allow the weevils to penetrate the grains.

Burning of sorghum with banana leaves was mentioned by 17 out of 102 (16.7%) respondents. This method was only found in Kabuyanda Sub County, sorghum is slashed from the husks and heaped and bit by bit are burnt using dry banana leaves or grass. The ash and the sorghum are stored together and the pests do not attack the sorghum. The burnt sorghum is only for consumption and making of local brew since it cannot be planted as it cannot germinate.

Spreading of Irish potatoes on the ground was mentioned by 43 out of 102 (42.2%) respondents. The Irish potatoes from the gardens are first sun dried on an open ground in the compound for almost one week where soil is removed and those that were cut during harvesting. There after they are put in a store or in one room in the house where they are spread and kept there for more than 6 months without germinating or rotting.

A unique form of preservation that was mentioned during a focus group discussion in Kyempara village, Kabingo Sub County was dipping of sacks in diluted ambush and then sun dried. This was mentioned by 09 out of 102 (8.8%) respondents. The beans or maize are then put in the sack; respondents revealed that the weevils cannot attack the grains since the smell of ambush repels them.

It can therefore be observed that sun drying is very essential in food preservation in Isingiro District since it is applied by all respondents. In addition, it is the first practice before the application of other preservation practices such as application of local pesticides and ash. It is an intermediate process in the processing of food; foods need to be dried before they are ground into flour. Preservation of foods using indigenous practices and technologies enhance food availability and access to household in periods of scarcity. IAK preservation further enhance food security by stabilizing food supplies beyond the season of production. Preservation also promotes great diet diversity and gives people access to a wider choice of products and hence to a higher level of nutrients such as vitamins and minerals than they would otherwise consume (Mukiibi, 2001)

3.3. Rapping Pieces Rat Poison in Black Polythene Bags and Putting Them into Sacks of Beans and Maize (Unique Concoction; Not an IAK)

Rapping pieces rat poison in black polythene bags commonly known as obuvera was mentioned by 87 out 102 (85.3%). It was revealed during the study that rat poison is thoroughly rapped into obuvera to the extent that someone cannot smell it and it is then inserted into the middle of the sack of beans or where they are heaped in the house or granary. The smell which is not detected by people repels bean weevils and they cannot attack the beans and maize.

Through observation, I was shown how it was being done and even the beans were not having any smell of the rat poison. The rat poison is a form of a modern science used to kill rats, but not to control bean weevils but people have modified it and used it in a totally different way. The respondents further revealed that in most produce stores it was what is used to preserve the produce from weevils. Its effect on biosafety and human health and how it repels the bean weevils require another study.

3.4. Indigenous Agricultural Knowledge for Food Storage

Storage is an important component of food security and a home cannot be food secure without storing food(Karyn and Mo, 2011).

IAK Practices Used to Store Food	*Frequency	%
Storage in sacks and placed on a wooden platform made of trees in one room inside house	64	62.7
Storage in sacks and placed on tree poles laid on the floor in one room inside house	73	71.6
Heaping of the produce in one corner of the residential house	33	32.4
Adding a room on the residential house to act as a granary with the entrance inside the house	14	13.7
Specific houses as granary	42	41.2
Traditional granaries	09	8.8

Table 3: Showing Food Storage Practices
Source: Field Data 2017
**Multiple Responses*

3.4.1. Storage in Sacks and Placed on A Platform Made of Trees in One Room Inside the House

Storage in sacks and placed on a platform made of trees in one room inside the house was mentioned by 64 out of 102 (62.7%) respondents. A platform made of trees is constructed inside the residential house in one of the rooms next to the dining room. The platforms; observed were between 1 - 2 meters high and 3 - 4 meters in length depending on the size of the room. After sun drying, the produce is put in sacks and placed on the plat form. The respondents revealed that this kind of storage was secure from thieves who would easily break into it in case it was outside like the traditional granaries. Relatedly, in Malawi, a raised wooden structure known as the msanja constructed above the fire place is used as a storage place for grains such as millet, sorghum, maize and all sorts of peas. The reason for storing harvested crops in this structure was to protect them from weevils and other pests. The soot coating made grains bitter and not edible by both pests and rodents. This was not only a cost-free technology but an effective way of ensuring food security (Kamwendo & Kamwendo, 2014).

Deviating from the above, in Nigeria, yams are stored in barns, which are usually built on an open ground but is usually shaded to protect the yams from the scorching effect of the sun. barns basically consist of walls of vertical poles cut from the bush or planks bought from the market, if left unbarked, will take root when set on the ground (Ezeike, 1995). Barns are effective for yam storage especially in the dry season when yams can be stored for up to six months

3.4.2. Storage in Sacks and Placed on Poles Laid on the Floor in One of the Rooms in the House

Storage in sacks and placed on poles laid on the floor in one of the rooms in the house was mentioned by 73 out 102 (71.6%) respondents. Sun dried big poles of trees such as eucalyptus trees are placed on the floor where the sacks are placed. The trees prevent moisture from the soil entering the produce or in case water is poured on the ground it does not affect the produce and hence it remains secure. In Kenya, as an indigenous grain storage strategy, sneeze wood is used for storing maize. 'Sneeze wood' (Ptaeroxylon obliguum) leaves and bark are used for storing maize. Branches of sneeze wood are used to store unshelled maize. The bark of the tree is burnt and the ash is also mixed with grains while storing. The powdered bark is also an effective pest repellent. The smoke out of burning sneeze wood also helps in warding off insects during storage of maize (Asogwa, 2017).

3.4.3 Heaping of the Produce in One Corner of the House

Heaping of the produce in one corner of the house was mentioned by 33 out of 102 (32.4%) respondents. This is where sun dried maize, beans, ground nuts and millet were heaped in one corner of the room on the floor. This method was found to be risky in that the produce easily affected by the moisture from the soil and termites. Deviating slightly with the above method, Chirimuuta, et al, (2011) established that in Zimbabwe, dried foods like corn, dried pepper and dried vegetables are stored over the fireplace to prevent spoilage of grains. They are also stored in bags with the combination of local pesticides like pepper, tobacco, neem leaves, wood ash etc. Weevils could be prevented from burrowing all kinds of grain by putting dry gum tree leaves between layers of grain in the sacks or granary.

3.4.4. Adding a Room on the Residential House to Act as a Granary

Adding a room on the residential house to act as a granary, with the entrance inside the house was mentioned by 14 out 102 (13.7%). A room is added on the house as an extension, but purposely for storage of food stuffs. In most cases a platform is constructed in it where the produce is placed either in sacks or not in sacks or big dry poles are laid on the floor where the produce either in sacks or husks are placed. This is another new way of granaries in that the traditional

granaries are easily accessed and broken into by thieves as earlier on indicated. In most case, through observation; these room had very small windows such that even when a thief comes; it is hard for him to enter and as he struggles, he would be head.

Specific house constructed in permanent or semi-permanent materials with a number of rooms serving many purposes such a kitchen and one or 2 rooms as granaries was mentioned by 42 out 102 (41.2%). These are permanent or semi-permanent houses with strong metallic or wood lockable doors and windows. These granaries are not easy to break through and it is one way of controlling theft and making sure that your produce is secured from thieves who are a menace to food security in the area.

3.4.5. Traditional Granaries

Traditional granaries were mentioned by 09 out of 102 (8.8%) respondents. There were found to be made of simple materials and placed on a plat form made of strong poles. Some of these granaries had metals rapped around their poles in an inverted funnel shaped form to prevent rats from entering the granaries. Through observation one can easily see that they are easy to break through by thieves and that's why some people were not using them. Besides exposure to thieves, found that they are also exposed to rodents, pests and rain. They are relatively expensive to maintain as repairs have to continuous compared to a permanent store attached to the main house inside the main house.

In agreement with the above findings, it is revealed that in Zimbabwe, local granaries known as matura/ tsapi in Shona or izipala in Ndebele are still used. They are cleaned, smeared with cow-dung before being filled with grain and then latter completely sealed after harvest have been put in. The sealing itself was very critical and it was informed by a lot of local wisdom on the life cycles of pests and pest control systems. Sealing the granary ensured that no living organism accessed oxygen for respiratory and reproductive purposes (Chirimuuta, et al., 2011).

On the contrary, another study was conducted by Udoh, et al. (2000), on the storage structures and aflatoxin content of maize in five agro-ecological zones of Nigeria. The study found maize-cribs efficient, as they were associated with decreased aflatoxin contamination than tanks and sack bags. The aflatoxin contamination was associated with insects' infestation, which suggested that tanks and sack bags were more exposed to pests or insects than maize-cribs (Udoh, et al., 2000). The crib system had rat guards, wire mesh and corrugated iron sheet roof which according to Udoh, et al. (2000), was an FAO recommended crib structure. This shows that a maize-crib can be a more efficient storage system for smallholder farmers, hence a need for its promotion along MAP.

3.5. IAK Used in Banana Production in Isingiro District

Isingiro District's economy is largely informal, with 89.2% of the people employed in the agriculture subsistence sector. Bananas / plantains commonly known as matooke are the main food crop and cash crop of the district (Isingiro District LGDPII2015/ 2016-2019/ 2020). Banana production is very important as it contributes towards food security to all the people of the district. The average size of land under banana production is currently 2-5 acres (Isingiro District LGDP 2011/ 2015-2015/ 2016). The lack of bananas in a plantation symbolized food insecurity in the household. Unlike other crops grown in the district, matooke stands out to be unique since it is a perennial crop while others such as maize and beans are seasonal. During the study, it was found that most of the matooke grown in the district were indigenous types of matooke. There was nowhere in the district where GMO or hybrid banana plantation was found and all the respondents were using mainly IAK practices in maintaining their banana plantations.

The respondents were asked to describe the indigenous agricultural knowledge used in the management of their banana plantations.

IAK Practice Applied in Banana Production	Frequency	%
Weeding, prunging, detrashing and mulching with banana leaves and leaf sheaths	102	100
Mulching with grass	23	22.5
Use of a mattock hoe or an old hoe to remove the cone	65	63.7
Digging of troughs to hold the water	97	95.1
Adding goat dung	78	76.5
Forked stick for removal of male bud	43	42.2
Planting of bull heads	26	25.5
Variety selection	85	83.3
Adding cow dung	58	56.8
Use of pegs	63	61.8
Banana wilt control	102	100

Table 4: Showing IAK Practice Used in the Management of Banana Plantations
Source: Field Data 2017
**Multiple Responses*

According to table 10 above, it was found that all the 102 (100%) respondents were weeding, prunging and mulching their banana plantations using banana leaves and leaf sheaths. Weeding involved use of a pang or chisel shaped tools and the hands to pull the weeds from the banana plantations. In the newly planted banana plantations and where weeds were hard to remove using a panga, old hoes were used. It was revealed that the use of a panga and chisel shaped

weeding tools and the hands do not loosen much the soil, hence remaining intact and not susceptible to soil erosion. It was also found that some farmers were digging pits in their plantations where they were heaping the weeds and when filled they would cover them as a way of controlling weeds since the weed seeds cannot germinate when covered with a lot of soil. In addition, this practice had an advantage of adding green manure in the soil and trapping rain water. In Tanzania, when the farmers regard weed competition as negative for crop growth, they perform superficial hoeing, and leave the weeds on the soil surface as protective mulch, to recycle nutrients, and to allow nitrogen assimilation through the bacteria decomposing the plants (Adedipe, et al., 2004).

In addition, as one weeds, he or she could do prunging simultaneously; but in most cases the two were being done separately. Prunging and detrashing required a skill to know which peeper, maiden sucker or leaves to remove from the mat depending on the direction of the flow of rain water into the banana plantation, the distance from another mat and its strength. Through observation, mats that had big bunches were having 2-3 plants and a distance of 3-4 meters away from each mat. The old one having a banana, followed by two of the different size and growth. The tools for prunging included the panga the most common tool, hoe and detrasher.

Mulching banana plantations using banana leaves and leaf sheaths was the most common type of mulching used by all the respondents. The leaves for mulching included fresh, those that have turned yellowish and the dried ones. In addition to mulching the leaves were removed to allow the sun to penetrate into the plantation and wind to pass through. Towards the rainy season, the removal of 2- 3 leaves from the banana bearing plants was emphasized since the first rains are usually accompanied by winds and thunderstorms. Having few leaves enabled the winds to blow smoothly through the plantation without falling them down.

The leaf sheaths for mulching were got from the mat when they are almost half way dry, when mature bananas were cut for selling or eating and when unwanted plants were removed from the mat. They were opened and placed on the ground uniformly one after another like a sitting mat. In other instances, like in Masha and Kabingo sub counties, they were chopped and heaped near the banana mat about 2 - 3 feet away. It was observed during the study that in most well-maintained banana plantations, the mulch was not close to the mat but 1-2 feet away.

Mulching using swamp and savanna grasses was revealed by 23 out 102 (22.5%) of the respondents. These are grasses that are got from the swamps or over grown farm lands and taken to banana plantations for mulching. Very few respondents were found to be applying this practice. Those that applied it were those near the swamp who could easily access it but not all those who were near the swamp were mulching using it; as it required a lot labour which some families lacked. Most of the people that mulched using swamp and savanna grasses were relatively rich respondents. Through observation, one could verify this by looking at the nature of the houses and their roofs, possession of the solar systems, water tanks and the means of transport owned.

It was further revealed that mulching using grass was expensive in terms of buying and transport as it required to hire a tipper or a lorry to transport the grasses. During the study, it was revealed that a bundle of swamp grass cost between 300 – 500/= depending on the size while hiring a tipper or a lorry cost between 60,000 – 150,000/= depending on the size and where you are taking the grass. This was found out to be very expensive to the subsistence farmer as it would require a number of trips to cover the banana plantations and that's why few were applying the practice. Those that applied it, had better looking plantations with big bananas. Even during the dry season, the plantations looked as if it was being irrigated. Mulching conserves water in the soil and protects the plantation from soil erosion by both wind and ran offs (Shirish et al., 2013).

Digging ditches / trenches in banana plantations to hold the water was revealed by 97 out 102 (95.1%). The troughs were put in the banana plantation to hold water whenever it rains. This is a practice to control soil erosion by rain water. The ditches hold the water longer allowing it to sink into the soil gently to the benefit of the plantation. Another use of ditches though done by few was growing beans on top of them instead of just leaving it hence efficient utilization of the ditch since the beans do not interfere with the main purpose of the trough and do not compete for plant nutrients with the bananas.

Adding goat dung into the banana plantation was revealed by 68 out 102 (66.7%). This involved collecting goat dung for some time and when a reasonable heap is gathered, they are then taken to the banana plantation. The application of goat dung varies; some respondents revealed digging pits near the banana plantation about 1-2 feet away from the banana mat and then cover it with the soil and others mentioned spreading it across the plantation, followed by ploughing. Avery large number of respondents were found to be applying goat dung into their plantations as indicated by the percentage, because most respondents had goats hence easy to get. However, it was found that it takes time to get a reasonable amount of goat dung due to the nature of goats being small animals.

Using of mattock hoe, commonly referred to as ekifuka or an old hoes culturally referred to as efuni to remove the corm from the banana mat was revealed by 62 out 102 (63.7%) of the respondents. Corms remain on the banana mat when a mature plant is harvested for eating or selling. When left in the soil, rain water cannot sink through them to the roots of the banana plants. This leads to growth of weak suckers that easily fall due wind and production of small bunches. The removal of corms also helps to remove pests or banana weevils that are found in the corms instead of encroaching to another banana plants.

Removal of male bud using a forked stick was mentioned by 58 out 102 (59.9%) of respondents. The forked stick is used to remove the male bud from the banana instead of using a detrasher or a panga. The forked stick was indigenously developed as measure to stop the transfer of banana wilt disease. It was realized that by using a detrasher to remove the male buds from many banana plants was leading to the spread of banana wilt in case an affected plant is among those cut. The forked stick is used in such a way that you hold the male bud between it and twist leading to its breaking from the banana ranchis. The use of a forked stick to remove a male bud is a recent innovation which indicates that indigenous

knowledge is not static and the people continue to innovate when confronted with new challenges in food production among others (Growing, et al., 2004 and UN, 2016).

Planting the bull heads was revealed by 47 out 102 (46.1%). The bull head is the lower part of the banana that remain when a mature banana is harvested for eating or selling. The bull head has corm and at times peepers growing around it. They are selected depending on the variety, cut to the height between 2-3 feet, one and half feet are planted in the soil while remaining part is left exposed to the surface. Planting of the bull heads is also a new innovation towards the management of banana wilt disease. It was found out during the study that planting of maiden suckers was not effective in that you may plant suckers that are already infected and cannot grow longer without rotting. The bull heads when planted produce new suckers that are not infected since they are got from the banana plants that were not infected. In addition, they have an advantage in that the coming up banana sucks are like those from the mat, they grow up properly and even bear big bananas. One male respondent in a focus group discussion in Kabingo Sub County had this to say:

Banana variety selection / seed selection this was mentioned by 85 out 102 (83.3%) of the respondents. It was found out during the study that most of the respondents were carrying out seed selection of banana suckers to plant. The preferred types like the selection of bull heads above are those types that bear big bunches with elongated fingers. Some mats are left intentional to have more suckers where they would be got from. In some other instances, people would go to the neighbours or friend at a distant place to get the best suckers. Planting of suckers was found out to be the most commonly used method of planting bananas because someone can easily get many suckers for planting compared to the bull heads which are got mainly at the time of selling. Like in the case of bull heads it was found out during the study that the preferred varieties included; Kyetengwa, Enzimbahima, Mbwasirame, Enjog bakazi, Mujaba, ekyera mukiira and Kibuzi. During this research there was no where it was mentioned that banana suckers were being sold to anyone who wanted them.

Putting cow dung in the banana plantations was mentioned by 38 out 102 (37.5%) of the respondents. This is not the percentage of people who actually put cow dung into their plantations. It was found during the study that most respondents mentioned it but were not actually doing it. The study revealed that few were doing do due to the costs involved. Those without cows were buying it; and by the time of the study a small tipper cost between 60,000 – 80,000/= without transport and a big lorry cost between 100,000 - 150,000/= without transportation costs. This practice was found to be expensive to peasant farmers for they cannot afford it. In areas where people were not keeping cattle or the terrain of the area not conducive to cattle grazing like in some parts of Kabingo and Kabuyanda the purchase of cow dung was very expensive and rarely applied. This is one of the reasons as why MVP encouraged the people of Kabuyanda Sub County to start the practice of applying banana sheathes as green manure for their plantations which was exhaustively discussed under MVP and food security in Kabuyanda in Sub County.

It was further revealed during the study, that cow dung was not taken immediately from the kraal or where the cows are staying. From the kraal, it was first heaped and then taken near the banana plantation where it dried and all the urine and water drain off. To be sure that it was ready for taking to the banana plantation the weeds would start to grow on it. Even those who were buying would first put it near the banana plantation for some time until they are sure that it has dried properly and there is no urine or any freshness in the cow dung and weeds have started to grow on it. It was revealed during the study that improperly dried cow dung burns the banana plantation leading to poor growth. In properly managed banana plantations pits would be dug 1- 2 feet away from the mat and 1 ½ - 2 feet deep. The workers would then carry cow dung on wheel blows or in sacks and put small heaps into the pits and cover it with the soil. In some instances, some farmers were not digging pits but simply put it near the mat plough with the soil. This practice was found not to be good since it makes the roots the banana plantation grows towards the surface. Application of cow dung to plantations enhances soil fertility, improves the quality of the plantations, the size of bananas produced which contributes to food availability, access and stability components of food security.

Replacing the banana suckers infected with banana wilt was mentioned by all the 102 respondents (100%) of the respondents. The respondents revealed that if not continuously replaced the plantation can be extinct. This was locally referred to as okutera ebiraka literally making patches. The replacements were made either with bull heads or suckers; like in other aspects mentioned above the preferred variety types were the ones planted to replace the infected. They were not planting exactly where the infected banana was removed but about 2 – 3 feet away, because not all the suckers at a mat would be infected at the same time. Through observation and narratives by respondents you would find only one sucker infected and others not.

Use of forked poles was mentioned by 63 of 102 (61.8%) of respondents. Pegs are forked tress or straight trees nailed with small trees towards the top to make a V shape. These are put on sucker bearing the banana that is too heavy for the sucker to hold it until it matures or the sucker has started to bend due to the wind or it's weak. Pegs were a common practice with most respondents who had good plantations.

3.6. Banana Bacterial Wilt Disease Control

Banana bacterial wilt disease control was mentioned by all the 102 (100%) respondents. The study found that the biggest challenge facing banana production in Isingiro District was banana bacterial wilt disease. All varieties of plantains grown in the district are susceptible to banana bacterial wilt disease and research has shown that there is no MAP that has so far been developed to control the disease; it is only cultural practices (IAK) that are therefore the most practical recommended for the control (Tushemereirwe, et al., 2003; Ssekiwoko, et al., 2006; Ngambeki, et al., 2006; Kubiriba and Tushemereirwe 2014).

According to the respondents the signs of the disease on the banana sucker included fresh banana leaves turning yellowish, leaves withering and falling, ripening of matooke when still young, yellowish pus from the cut banana sucker, withering of cigar leaf and banana fingers turning brownish and yellowish. These findings are in agreement with Tushemereirwe, et al., (2003) and Jogo et al., (2011) regarding the symptoms of the disease. This indicates that people are aware of the disease, its symptoms and the stages which is essential its control.

It was found that IAK methods of controlling banana bacterial wilt were making impressive success towards its control. The following measures that were being done:

Removal of male bud with a forked stick, cutting the infected banana sucker, its leaves and banana into small pieces and heaping them at one place. Use of two pangas in the maintenance of banana plantations; one for cutting the infected banana plants and other for pruning, removing the sheathes and unwanted suckers from the banana mat of uninfected plants. The use of two pangas was found to be effective in the control wilt in that by using one pang one would be spreading the disease from one sucker to another in case one prunes the infected one. Care was emphasized not to confuse the two pangas. The one for cutting the infected was usually small or old compared to the one for use on the normal ones as shown in the plates below:

Putting the panga in fire after cutting the infected banana sucker was also a method used by respondents in the control of banana wilt.

Regular inspection of the banana plantations looking for the infected banana suckers was mentioned as an effective way of controlling wilt.

Application of urine was mentioned as a measure being used to control banana bacterial wilt. Urine whether human or animal was poured on the banana mat where an infected sucker was cut. It was believed that urine kills the wilt bacteria. Most of the urine being applied was got goats and cows that was collected in the morning.

Alerting your neighbours of infected suckers or bananas in his or her plantation is one the effective methods by community members in the control of the disease.

There are isn't any MAP control approach against banana bacterial wilt disease being emphasized, those that were emphasized at the onset of the disease were later found to be ineffective compared to IAK practices or were already developed by farmers locally. IAK practices are being portrayed as cultural interventions in most literature on banana bacterial wilt disease; Ssekiwoko et al., (2006); Ngambeki et al., (2006); Kubiriba and Tushemereirwe (2014). The removal of the entire mat where a sucker was found infected was recommended at the beginning as one of the MAP interventions; Tushemereirwe (2004). Over time the recommendation changed to a single sucker removal an IAK practice. This was after it become evident that infection starts from the upper parts of the plant on the inflorescence or leaf and takes some time to get to the lower part of the plant (Ssekiwoko, et al., (2006). The removal of a single sucker has been evaluated and found effective in Kenya and DRC. In such a scenario where IAK practices are being recommended by scientists as the best approach towards the control banana bacterial wilt disease, one would argue that integrating IAK and MAP for the control of the disease is a better approach as both will complement each other. In respect to food security, the banana bacterial wilt disease has negatively impacted on all the pillars of food security of availability, access, utilization and stability

3.7. Contribution of Indigenous Agricultural Knowledge towards Sustainable Food Security in Isingiro District

Contribution	*Frequency	%
Availability of food in the homes	102	100
Indigenous crops are most often disease and pest resistant	102	102
Availability of healthy crops	73	71.6
Availability of seeds	102	100
Improvement and preservation of soil fertility	85	83.3
Storage of food	62	60.8
Crops tolerant to hash weather condition	94	92.2
Reduced damage to food produced	64	62.7
Aids water aeration and retention in the soil	61	59.8
Non-disruption of farming practices	40	39.2
Production of high yielding crops	56	54.9
Weather forecasting	76	74.5

Table 5: Showing the Contribution IAK towards Sustainable Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

The study finding show that most respondents were aware of the contribution of IAK towards sustainable household food security in their homes. The contributions mentioned included availability of food in the homes mentioned by all 102 (100%) respondents, availability of health crops revealed by 73 out 102 (71.6%) respondents, improvement and preservation of soil fertility 85 out 102 (83.3%) respondent. Storage of food was mentioned by 62 out 102 (60.8%) respondents and resistant crops to disease and pest resistant crops mentioned by all 102 (100%) respondents and tolerant crops to hash weather conditions was mentioned by 94 out 102 (92.2%) respondents and reduced damage to food produced was mentioned by 64 out 102 (62.7%) respondents. Aiding water aeration and retention in the soil was mentioned by 61 out 102 (59.8%) respondents, non-disruption of farming practices was mentioned by 40 out 102 (39.2%) respondents, production of high yielding crops was mentioned by 56 out 102 (54.9%) respondents and weather

forecasting leading to early germination was mentioned by 76 out 102 (74.5%) respondents. The findings show that most of the respondents appreciated the contribution of using their IAK practices towards sustainable rural household food security. This is because people are familiar with IAK practices, skills, technologies, and they apply them with confidence. The high percentages for IAK contribution mentioned further shows that people are less dependent on MAP towards food security.

Food security is built on four pillars: (i) Food availability: sufficient quantities of food available on a consistent basis; (ii) Food access: having sufficient resources to obtain appropriate foods for a nutritious diet; and (iii) Food use: appropriate use based on knowledge of basic nutrition and care; (iv) Stability in food availability, access and utilization (UN-HLTF,2011& FAO 2008). Food security at household level further involves the following dimensions; sufficiency, quality and safety. Sufficient quantities of nutritious food are available to individuals, the food should be comprising an adequate diverse diet to meet nutritional needs that are culturally acceptable and the food does not harm any person if prepared and eaten according to intended use. Research; (Nadi, et al., (2013); Asogwa, et al., (2017); Makuria, (2014); Ladislaua , et al., (2010); Abiola, et al., (2011) & Martha, (2013) has shown that IAK contributes greatly towards the pillars and dimensions of food security in rural areas and that any attempt to promote food security that ignores peoples knowledge fail or scores little success, hence the advocacy for integrating of both IAK and MAP in order to enhance food security in rural areas

Rural women particularly are one group within a community who hold enormous indigenous knowledge of food production, storage and processing which can assist modern efforts of reducing food insecurity and hunger (Asogwa, et al., 2017). Brown (2011) noted that women play a significant role in food security, though they are constrained by various factors that include lack of secure land rights and cultural practices.

Certainly, the role of IAK practices in food security cannot be overlooked, it's cheaper, culturally acceptable, economically and socially feasible as well as a sustainable.

3.8. Challenges of Using IAK towards Sustainable Food Security in Isingiro District

The respondents were asked to mention the challenges of using IAK towards sustainable food security. Their responses are presented in the table below;

Challenge	Frequency	%
Lack of documentation / Not being recorded	98	96.1
Not being taught in schools	81	97.4
Lack of recognition	72	70.6
Despised by the educated	93	91.2
Not being used by most of the rich people	89	87.3
Some practices cannot be used on layer scale	32	31.4
Extension workers do not know it / teach it	09	8.8%
Lack of linkage between research and agricultural extension service providers	13	12.7%

Table 6: Showing the Challenges of Using IAK towards Sustainable Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

The study revealed that most of the respondents knew the challenges facing their knowledge despite its numerous resource fullness. Lack of recording or documentation was mentioned by 98 out 102 (96.1%) of respondents, not being taught in schools was mentioned by 81 out 102 (79.4%) respondents, lack of recognition was mentioned by 72 out 102 (70.0%) and being disposed by the educated was mentioned by 93 out 102 (91.2%). Not being used by most of the rich was mentioned by 89 out 102 (87.3%) respondents, some practices cannot be used on large scale was mentioned by 32 out 102 (31.4%) respondents and extension workers not knowing it or teaching it to the people was mentioned by 09 out of 102 (8.8%) respondents and lack of linkage between research and agricultural extension service providers was mention by 13 out of 102 (12.7%) respondents.

The challenges mentioned hindered the effective use and application of IAK for sustainable food production. Lwoga & Ngulube (2008) observed that lack of a cohesive approach for managing indigenous knowledge suppresses efforts of the poor to take advantage of their innovation and still to improve their farming activities. This challenge is further compounded by the fact that there is a low rate of adoption of MAP despite the high attention it receives (Ngendello, et al., (2003).

3.9. Conclusion

This chapter has revealed that IAK practices are very important not only that they provide effective alternatives to MAP but gives extra options to local people in their endeavour towards sustainable house hold ford security. The search for sustainable house hold security in Isingiro district should not only look for feasible options from MAP. The people of Isingiro District have developed a complex IAK patterns that are sustainable, easy to use, affordable and continually inventing new ones. Despite all this, there is nowhere integration of IAK into MAP mentioned and no framework has ever been put in place for mainstream IAK along MAP; which this study is advocating for.

4. Modern Agricultural Practices and Sustainable Food Security in Isingiro District

Modern Agricultural Practices involves the planting of hybrid seeds of single crop variety, use of modern farm machinery such as tractors, seed diskers, harvesters and threshers, use chemical of fertilizers, pesticides in an optimal combination with water (Mann, 2003). Modern agricultural systems have been developed with two related goals; to obtain the highest yields possible and to get the highest economic profit possible. In pursuit of these goals, there is intensive tillage, monoculture, application of chemical fertilizer, irrigation, chemical pest control, and genetic manipulation of crop plants (Brown, 1998& Gliessman, 1998)

The aim of this chapter was to find out the MAP being used by the farmers in Isingiro District in food cultivation, preservation and storage. The operations of OWC, the agricultural extension services in the district, the challenges faced in the use of MAP and the contributions of MAP towards food security in the district were also in the study. The respondents revealed the following in respect to the questions generated from the aim of this chapter

4. 1. Modern Agricultural Practices Used in Cultivation in Isingiro District

MAP Used in Cultivation	*Frequency	Percentage
Use of a tractor	12	11.8
Spraying of beans	16	15.7
Spraying of maize	21	20.6
Planting of hybrid seeds	33	32.4
Planting crops in parallel lines with equal spacing	38	37.3
use of fertilizers	23	22.5
Spraying cabbages and tomatoes	35	34.3
MAP used in food preservation		
Lindane dust	21	20.6

Table 7: Showing Modern Agricultural Practices Used in Cultivation in Isingiro District
Source: Field Data 2017
**Multiple Responses*

According to the table above, the use of tractor was revealed by 12 out 102 (11.8%) of the respondents. The small number was due to the costs involved, the size of the land and the topography of some parts of the district. By the time of the study, the tractor from Ministry of Agriculture, Animal industry and Fisheries was parked at Masha / Butenga Trading Centre in Masha Sub County.

The size of the land owned by most inhabitants also hinders one to use a tractor. Majority of the people had small lands where they cultivate seasonal crops such as beans and maize which made the use of a tractor not cost effective even if one would afford it. The average size of land holing ranges from 2- 4 hectares (Isingiro District LGDP11 2015/2016 - 2019/2020).

According to the CDO and Chairperson Local Council III Masha Sub County the cost for hiring the tractor ranged from two hundred thousand Uganda Shillings (200,000/=) (54 US $) to one Million Uganda Shillings (1,000,000/=) (270 US $) and more depending on the size of the land one would wish to cultivate and the distance from the station. In addition, one had to meet the costs for allowances of the two operators. Besides it was revealed that had to the operators some side money as a motivation to them to do a lot of work for you in a short time.

The hilly terrain or topography of the western part of the district make the use of a tractor in cultivation impossible; making the use of a hand hoe the only option. Isingiro District lies between altitudes 1200-1810 meters above sea level. Area west of the district Nyakitunda, Nyamiyanja, Ngarama, Kabingo and Kabuyanda hills have the highest altitude up to 1810 meters above sea level, (MRDPM, 2016). Thus, even if one wants to use a tractor, the terrain cannot allow its application.

Spraying of beans was mentioned by 16 out 102 (15.7%) of the respondents. The respondents revealed that there are various pests and diseases that were attacking beans; eating the leaves and turning the leaves yellowish; thus, they had to spray to kill the pests. It was revealed that the drugs that they got from the markets and agricultural shops were not effective. One would spray and sometimes the disease would be controlled but most of the time they sprayed but the pests and diseases continued leading to total failure. The drugs applied were found out to be expensive to the local farmers and it was mainly the rich in the area who applied spraying. These findings are in agreement with Swaibu, et al., (2018); Mukombozi (2013) & Akullo, et al., (2007).

Spraying of maize was mentioned by 21 out 102 (20.6%) of the respondents. Maize was being attacked by a strange pest; the army worm locally known as Kanyogonibwa. It was eating the plant leaves starting from inside where the shoot was growing. According to the respondents it was a strange pest in that it was different from the common pestthat would attack very few crops towards maturity. The respondents further revealed that the drugs they were using were not effective since despite spraying, the pest was not being controlled.

Planting of hybrid maize and bean seeds / NAADS seeds as they were commonly referred to was revealed by 33 out 102 (32.4%) of the respondents. They were available in shops in towns and in trading centers and by the time of the study, a kilogram ranged between 4000 – 5000= which was found to be expensive to the farmers.

Other people who planted hybrid seeds got them from their respective parishes after being delivered by OWC. Those who got it mentioned that they were given very little in that each house hold was given half a kilogram of maize or beans seeds which could only plant less than a tenth of an acre. This intervention by OWC was not being seen as a serious intervention according to respondents. Indeed, by giving a house hold a half a kilogram of seeds to plant as a measure towards food security is not a viable measure towards sustainable food production and food security. This is the reason as to why some respondents mentioned that some of them sold them at the trading centers at 2000 - 2500/= because people never valued the intervention. The respondents further revealed that one could not replant the seeds after harvesting; you have to keep buying the seeds whenever it is time for planting this partly explains where few were planting hybrid seeds

Planting of crops in parallel lines with equal spacing was mentioned by 38 out of 102 (%) respondents. It was found out during the study that most of respondents who were growing crops in parallel lines with equal spacing were from Kabuyanda Sub-county due to the effect of Millennium Village Project, (This has been explained in chapter four) very few were found in Masha and Kabingo Sub-counties. Most of the crops grown in parallel lines with equal spacing were maize, beans, cabbages, carrots, and tomatoes. The spacing for maize as revealed by respondents was one meter and a half. A meter was measured by one normal stride of an adult person (They used strides because of limited measuring tapes). In each hole they planted 2 or 3 seed; while the spacing of beans, was 1½ - 2 feet; one foot was assumed to be equivalent to two stretched hands. In both calculations of measurements, a small stick would be used during planting to show where to dig and put the seeds. The spacing was important as it allowed the sun to penetrate the garden, winds to blow through, easy inspection and spraying for those who were doing it.

Application of fertilizers was mentioned by 23 out 102 (22.5%) of respondents. Different respondents revealed to have applied fertilizers in the growing of maize, beans, tomatoes and cabbages. They mentioned that like sprays, fertilizers were expensive to use and at times they could not work leading to poor harvests. The Economic Policy Research Centre (EPRC) and the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) had similar findings in 2015 that at least eight in every ten 50-kilogramme inorganic fertilizer bags on the Ugandan market do not meet the minimum quality standards. In addition, the study revealed that 67 per cent of samples from importers, 65 per cent from unregistered MAAIF retailers and 80 per cent of MAAIF registered shops were non-compliant. In spite of the challenge, it was found that if the right one is applied, fertilizers give a better yield though you need to keep applying them otherwise you get poor yields

In addition, there are other challenges of application of fertilizer such as lack of knowledge on its use and the type of fertilizers suitable for each crop. When to apply them, which are counterfeit or not and the effect of fertilizers on the soil and how to grow crops in a situation when you fail to get them; yet you need to use the same piece of land, thus not a strategy towards sustainable food security in Isingiro District.

Spraying of cabbages and tomatoes was mentioned by 35 out 102 (34.3%) of respondents. It was found out during the study; that all the respondents who were growing cabbages and tomatoes were spraying them mainly using ambush pesticide. Spraying kills pests and control diseases that affect cabbages and tomatoes.By the time of this study one big tomatoes costed two hundred shillings (200/=), a small one hundred shillings (100/=) and tin / basin costed thirty thousand (30,000/=). It was further revealed that the cost is higher during the dry season as it involves irrigating the garden.

4.2. Modern Agricultural Practices Used in Food Preservation in Isingiro District

Preservation of food using Modern Agricultural Practices was found to be used by very few people in Isingiro district. 21 out 102 (20.6%) of the respondents were found to be using modern ways of preservation of beans or to have ever used it. Most farmers were using indigenous pesticides and ash for preservation before selling them.

The application of pesticides such as lindane dust to dry beans was found out not to be effective at all times as regards preservation of beans. Respondents revealed that they did not understand its contents since they cannot read what is written on the containers; even those who could read could interpret them. They further revealed that there are some times when the pesticides fail to work and they keep adding more and more and even change and add another pesticide as advised by sellers of those pesticides. Similar findings were also found out by Okanya (2017), who conducted a number of surveys around pesticide use in the country and found out that application hazardous pesticides are on the rise in the country causing damage to the environment and human health. And that the absence of extension services in the country and other safeguards is making the increased use of pesticides disastrous. Kizito (2013), found out collaborative information in Uganda's two districts of Pallisa and Wakiso in Eastern and Central Uganda that some farmers mix two different pesticides to make the pesticide stronger. In addition, he found out that many agro-dealers and their staff are not professionally trained and lack adequate capacity to offer proper guidance to the farmers. Thus, it is not a cost-effective approach and this partly explains why few were using it.

4.3. Challenges of Using Modern Agricultural Practices in Food Security in Isingiro District

The respondents were asked about the challenges of using modern agriculture practices towards enhancing food security in Isingiro District. Their responses are presented in the table below;

Challenge	*Frequency	%
Hybrid seeds are expensive	63	61.8
Little seeds given by OWC	64	62.7
Drugs for spraying are expensive	76	74.5
Hybrid crops / GMO plants / NAADS crops as being easily attacked by pests and diseases	52	51.0
Hybrid seeds planted only once	49	48.0
Hybrid crop can't with stand harsh weather conditions	42	41.2
Failure of some MAP to control pest and diseases	47	46.1
Failure to germinate and to grow into big grains	44	43.1
Failure of fertilizers to work	05	4.9
Dislike of NAADS grains in the market	38	37.3

Table 8: Showing Challenges of Using Modern Agricultural Practices in Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

Hybrid seeds being expensive was revealed by 63 out 102 (61.8%) of respondents. The respondents mentioned that a kilogram of beans ranged from 10,000 – 15,000/= and maize between 4000 – 5000/= depending on the type. Hybrid seeds were available in big trading centers and towns in the area such as Kabingo and Kabuyanda. The respondents showed that it was expensive for them to for them to buy and at times not all would germinate; and they were planting 2 or 3 seeds so that in case one fails the other would germinate. The drugs in the seeds were also challenge as regards to the smell and the way of handling at planting. Some respondents mentioned stomach disorders and respiratory challenges when they plant them.

Little seeds given by OWC was revealed by 64 out 102 (62.7%) respondents. It was found out during the study that NAADS and OWC gave them seeds for planting especially maize and beans; but very little was given as already mentioned. Each house hold was given half kilogram of beans or maize seeds for planting something the respondents said could not cover a tenth of an acre. This made the intervention far less appreciated towards food security, yet the food security scheme is one of the core components of OWC, (NRM Manifesto, 2016-2021).

Pesticides for spraying being expensive was mentioned by 76 out 102 (74.5%) of respondents. The drugs used to spray beans, maize, cabbages and tomatoes were found to be expensive to peasant farmers. The price of drugs ranged from 40,000 - 100,000/= or more depending on how big the garden was and at times not working. This was found out to be expensive to the peasant farmers in the area which explains why very few were applying it in the control of pests and diseases.

Hybrid crops / GMO plants / NAADS crops[2] being easily attacked by pests and diseases was mentioned by 52 out 102 (51.0%) of respondents. Crops such maize, beans, sweet potatoes and cassava were easily being attacked by pests and diseases. The pests were eating their leaves for example maize and beans while sweet potatoes and cassava were being attacked by various diseases and hence not forming root tubers and if any very small.

Hybrid seeds planted only once was revealed by 49 out of 102 (48.0 %) of the respondents. The respondents narrated that hybrid seeds are only planted once and if you plant them again, they don't germinate.

Hybrid crops do not endure harsh weather conditions was revealed by 42 out of 102 (41.2%) of the respondents. The respondents recounted that hybrid crops can really grow in a situation when there is little rain fall and un predicted dry season.

Failure to germinate and to grow into big size maize or beans was reported by 44 out of 102(43.1%) of the respondents. The respondents revealed that there are situations when hybrid seeds fail to germinate or few germinate. As a measure against this, they were planting 2-3 seeds in each hole. In the event that they all germinate; others would be removed during the time of weeding. They further reported that there are situations when the maize or beans don't grow big sizes as expected and they are less like the local varieties.

A study by Mubangizi, et al., (2012) under ISSD Africa on Uganda Seed Sector Assessment 2012, found similar results that showed that seed quality assurance in Uganda is a major bottleneck in the formal seed supply system. The National Seed Certification Services (NSCS) was found under-capacitated to perform its official mandate of regulating and enforcing seed quality control mechanisms, and counterfeits are rampant on the market. Consequently, farmers have lost trust in formally produced seeds, keeping the adoption rates at low levels and contributing about 20 % of the seeds used by farmers in Uganda. Most of the seeds used in Uganda are supplied by the informal sector which stands at more than 80%; these are the seeds that are produced, sorted and stored using indigenous agricultural knowledge (Lwakuba, 2012).

Failure of some modern practices to control pest and diseases was reported by 47 out of 102 (46.1%). It was found out in the study that some of the modern agricultural practices being emphasized in the control of pest and diseases were hardly working and at times not working at all.

Relatedly, Danielsen, et al., (2014) notes that like most African countries, Uganda is ill equipped to safeguard crops against existing and emerging pest and disease risks associated with climate change, increasing globalization and human mobility. They went to argue that diagnostic services, are scarce and poorly coordinated. Kroschel et al., (2014) noted that major pest and disease outbreaks create shocks at local level and erode resilience of farming systems, perpetuating and deepening poverty. This explains farther why most farmers are still depending on local seeds despite the popularization of hybrid seeds. An approach that popularizes the use of both local and hybrid seeds can serve the Ugandan society better.

Failure of fertilizers to work was mentioned by 05 out of 102 (4.9 %) of respondents. It was found out in the study some fertilizers were not working as expected and others not working at all. They suspected that some may have expired and sellers change the labels or being counterfeit or not appropriate for the crops. This made some farmers to stop using them. This has already been explained under modern agricultural practices used in cultivation in Isingiro District above.

Dislike of NAADS grains in the market was mentioned 38 out 102 (37.3%) of the respondents. It was found out that the hybrid grains of beans and ground nuts mainly were not being liked in the market. The reasons given were that the test and color of the source was not pleasing to most people.

Despite the above challenges of MAP, they have value and are significant towards sustainable food security. They have their strength as well as weaknesses like the local varieties and that's why this study is advocating for the integration of both practices.

4.4. The Contribution of MAP towards Food Security in Isingiro District.

The respondents were asked to about the contribution of modern agriculture practices towards food security in Isingiro District. Their responses are presented in the table below;

Contribution	Frequency	Percentage
Food production	42	41.2
Hybrid crops maturing faster than local crops	16	15.7
Hybrid crops producing relatively big grains	16	15.7

Table 9: Showing the Contribution of Using Modern Agricultural Practices towards Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

According to the table above, contributing to food production was revealed by 42 out of 102 (41.2 %) of respondents. It was found out during the study that MAP was making a contributing towards food production but not as much as IAK. The respondents revealed that when grown and mature without being affected by pests and diseases and with rain in its time, they contribute towards food in the home steads.

Hybrid crops maturing faster than local crops was mentioned by 16 out 102 (15.7%) of respondents. It was revealed during the study that hybrid varieties such as maize, beans, sweat potatoes and Irish potatoes were taking a relatively short period unlike the local ones. The duration difference mentioned was between three to four weeks; indicating that they can provide food to a home before the local crops.

Hybrid crops producing big grains was equally mentioned by 16 out 102 (15.7%). The respondents reported that the hybrid grains were relatively larger than the local grains and that once you plant hybrids and grow without any interferences, you are able to harvest more compared to that one who planted the local varieties. This study did not go into finding how much is got from an acreage of land for either hybrid or local seeds.

From the above findings, the contribution of MAP towards food production in Isingiro District is minimal and less sustainable. Emphasizing MAP interventions alone neglecting IAK; which is used by most of the people in food production cannot not lead to rural household food security in the district and Uganda at large. An approach that that integrates both MAP and IAK in a food production system is likely to be a better intervention towards sustainable rural house hold food security in Uganda.

4.5. Operation Wealth Creation (NAADS) and Food Security in Isingiro District

Operation Wealth Creation (OWC) came into existence in June 2014, it was designed to correct the failures of NAADS at implementation level especially poverty reduction and sustainable house hold food security, (NRM Manifesto, 2016-2021). The redesigning of NAADS programme involved the deployment of UPDF officers first on a pilot in Eastern Uganda where the outcome of the military officers was impressive in 2 years according to the president. Basing on the lessons leant, a partnership between Makerere University College of Agricultural and Environmental Sciences, NAADS and UPDF was put in place to implement the New NAADS model. The goal of the partnership was to share knowledge and skills to address the challenges facing agricultural production in Uganda; sustainable food security inclusive (ACODE, 2015). After spending two weeks at Makerere University College of Agricultural and Environmental Sciences, Kabanyoro farm, the army officers were deployed in the entire nation with each army officer serving a constituency with 4 - 7 sub counties.

Isingiro District has 2 constituencies namely Isingiro North and Isingiro South constituencies. This study was carried out in both constituencies. Masha and Kabingo Sub Counties are in Isingiro South Constituency and Kabuyanda Sub County in Isingiro North Constituency. The two major components of OWC are sustainable food security and poverty alleviation. The food security strategies so far implemented by OWC in Isingiro District are distribution of food stuffs namely; beans and maize and giving hybrid seeds of beans and maize to thefarmers. In both situations, people were given very little amounts as already indicated rendering the interventions less significant.

During this study in Masha Sub County on 29/3/2017, OWC officer in charge of Isingiro North Constituency delivered 380 bags of maize of 10 kilograms each under the food security scheme to be distributed to the sub county. During an interaction with OWC officer, he had this to say:

This maize is supposed to be distributed tomorrow 30/3/2017 to parishes. Each cell in the sub county is expected to receive 20 kilograms where by each house hold is expected to get half a kilogram. The challenge is that the delivery is

late as the planting season is already over. They will be planted in the next season which will begin in September. There is a lively hood of people eating them, selling them.

Similar findings were reported by the Parliamentary Sectoral Commission on Agriculture, Animal Industry and Fisheries of the Implementation of the Operation Wealth Creation Programme in Uganda (2017). In Agago, Oyam and Nebbi Districts, it was found out that the inputs were delivered late in September / October and were also planted late. The crops could not withstand the long dry spell that run from late November till late March and ended up dying. Other field studies revealed that due to late delivery of inputs people do not pick them and they go to waste.

OWC was also found to be delivering inputs without informing the district leadership making it difficult for them to plan how to store and distribute the inputs. The study further revealed that OWC does not monitor the performance of the inputs distributed which left the programme without data on which it can base the supply of inputs in the future. It further showed that OWC delivery system was flawed, it was performing without information sharing and without local knowledge of the people showing what they want hence a failed initiative. Ogwang (2017) in his study in Gulu, Bushenyi and Bulambuli Districts found a similar situation to the extent that some district officials rejected the planting materials (seeds and seedlings) either because of late delivery, wrong variety or poor quality. It was upon such weakness in the operations of OWC that most people in the district never appreciated its approaches towards sustainable food production and food security in general in Isingiro District.

4.6. Agricultural Extension Services in Isingiro District and Food Security

Agricultural Extension Services include interventions activities by government and Non-State Actors that facilitate access by farmers, their organizations, and other value chain actors to knowledge, information, and technologies; mediate their interaction with other relevant organizations; and assist them to develop their technical and management capacity in agriculture and family life. The agricultural extension system includes the entire set of organizations and institutions (public, private, civil society), that are involved in providing agricultural extension services (MAAIF, 2016)

Each sub county in Isingiro District has an agricultural extension officer supposed to visit farmers and educate them to produce food, cash crops and animal production in order to enhance their way of living (Isingiro District LGDP11 2015/2016 - 2019/2020).

The respondents were asked to about the frequency agricultural extension workers from the sub county in the community with regard to visiting and meeting people to educate them on agricultural practices. Most respondents indicated that extension workers hardly visit communities indicating that the last visit was about ten years ago; while others could not remember when they were last visited or attended a meeting organized by agricultural extension worker. This showed that the extension services are weak on the ground and their contribution of agricultural extension services towards sustainable food security in the area is equally weak and negligible.

The respondents further revealed that when you need them you go to the sub county; but even it is rare to find them there; instead their services have been replaced by NGO work.

One female respondent in an FGD in Kabingo Sub County had this to say: There is no government extension work, it is only NGOs operating. An NGO in Kaberebere called "RUPAYI" taught us about modern farming methods like looking after banana plantations, making manure, control of banana wilt, making trenches in banana plantations and to how grow vegetables in the backyard.

A visit to this NGO found that its real name is Rural Health Promotion and Poverty Alleviation Initiative (RUHEPAI). RUHEPAI was founded in 2004 and registered in 2005. Its mission is committed to serve less privileged communities in Uganda through empowerment of women and youth to attain transformed livelihoods through their own participation. Its area of operation was found to be in Birere and Nyamuyaja Sub Counties but people in Kabingo Sub County near Birere Sub County are also benefiting from their interventions. Its aim is to enhance farm production and house hold income through banana production using organic farming practices

An interview with officers of the organization, revealed that the NGO was educating farmers on soil conservation methods, application of organic and farm yard manure, spacing, pruning, making of trenches in banana plantations and control of banana wilt. (M&E Officer, RUHEPAI, 2017).

A part from training and extension services, the NGO is giving farm inputs and implements to improve farming. Farming tools such as hoes, pangs, forked hoes, knap sack sprayers and matteo hoes are being given.

The MAP that the NGO was encouraging was use chemicals for spraying of tomatoes and cabbages during growth, but the use of artificial fertilizers was not encouraged. The reason being costs involved in buying, sustainability and its effects on the exhausting the soil. In all this NGO was focusing on application of organic farming centering on use of local materials, building on farmers' knowledge, but using less of MAP. One can easily assert that this NGO is integrating IAK along MAP towards sustainable production of bananas, the main food and cash crop of the people of Isingiro District.

4.7. Conclusion

MAP is expensive, not reliable, not always available and when available are expensive to acquire by the local people. Most people lack the knowledge and skills as regards their use and application and the agricultural extension services are thin on the ground if any. It is also important to note that accessing them involve another financial burden to the peasant farmer. Despite the continued funding and support from the government towards MAP, they alone cannot bring sustainable food security in the district. An approach that maximizes the strength of MAP and IAK in an integration frame work is the most appropriate towards sustainable food security in Isingiro district.

5. Aspects of Integration of IAK and MAP towards attaining Food Security in Isingiro District

Knowledge Integration (KI) is a process of synthesizing multiple knowledge models into a shared model (Yuxian 2012). A knowledge model is a set of knowledge of various types, facts, concepts, procedures, principles, skills that are structured by the linkage of the relationships. It is a cross disciplinary approach that capture and model knowledge into a reusable format for purposes of preserving, improving, sharing, substituting, aggregation and reapplying (Yuxian, 2012). Thus, KI is a process of incorporating new information into a body of existing knowledge with in an interdisciplinary approach; it involves determining how the new knowledge and the existing knowledge interact, how existing knowledge is modified to accommodate the new and how the new is modified in light of the existing knowledge.

5.1. IAK and MAP Activities Integrated in Cultivation

Activities Integrated in Cultivation	*Frequency	%
Use of a tractor in opening the land, ploughing and harrowing (MAP) and planting of maize or beans using a hoe (IAK), growing in parallel lines (MAP) and harvesting using hands (IAK).	12	11.8
Growing of one crop (MAP) either maize or beans of local seed variety (IAK) in one garden and parallel lines (MAP)	46	45.1
Growing of indigenous banana varieties (IAK) but spacing mats about 3-4 meters a part and having 2-3 suckers at various levels of growth (MAP)	63	61.8
Growing of hybrid breed maize seeds in lines (MAP) and intercropping them with local beans or ground nuts and cassava	42	41.2
Growing of hybrid maize seeds (MAP) by broad casting and intercropping them with beans	46	45.1

Table 10: Showing Aspects of IAK and MAP That Were Integrated towards Attaining Sustainable Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

According to the table 17 above, the use of a tractor in ploughing, harrowing, but planting maize or beans using a hoe, in parallel lines and harvesting using hands was mentioned by 12 out of 102 (11.8%) of respondents. This indicates that few people in the district were able to manage the use of a tractor in marking the land ready for planting. The use of human labour for planting, weeding and harvesting was found to cheap and convenient to the people since human labour is readily available

Ajah (2014) found corresponding information on factors limiting small-scale farmers' access and use of tractors for agricultural mechanization in Abuja, North Central Zone, Nigeria. The findings indicated that the major limiting factors to farm mechanization were the cost of hiring tractor services and inadequate sources of hiring points resulting in poor access to tractors and its implements. The above findings are in agreement to what (Munyambonera , Nampewo , Adong , & Mayanja , 2012)found out in their study on unlocking the dilemma of financing small holder farmers in Uganda.

Growing one crop of either maize or beans of local seed variety in one garden and in parallel lines was mentioned by 46 out of 102 (45.1%) respondents. This practice was mainly found to be Kabuyanda Sub County as the result of the Millennium Village Project. The growing of one type of a crop in a garden is an aspect of MAP, but growing of local seeds, use of a hoe in planting, weeding and harvesting using human labour are aspects of IAK. The growing of one crop in one field enables one to harvest a relatively high yield compared to one who does inter cropping. The local seed varieties were preferred because they are well adapted to the natural and cultural environment in which they are grown, they are of high quality in terms of food value and not easily susceptible to pests and diseases (Fajardo, Wilson , & Javier , 2014) and (Ponge, 2013)

Growing of indigenous banana varieties, spacing banana mats about 3-4 meters a part and having 2-3 suckers at various levels of growth was mentioned by 63 out of 102 (61.8%) respondent. The spacing and having 2-3 suckers mentioned are aspects of MAP, but growing of indigenous varieties is an aspect of IAK which gives an aspect of integration.

Through observation, one could see that indigenous bananas varieties are almost the only ones grown in Isingiro District and very few farmers were having isolated mats of hybrid varieties in or near the compound more less like flowers. Asked why hybrid varieties were grown in compounds, they revealed that when grow them in the plantation, they make the indigenous varieties grow poorly. However, this study didn't go in detail to find out why as it would involve a scientific research study on its own.

The growing of indigenous banana varieties, weeding, pruning, detrashing, replacement and all the tools used in the maintenance of banana plantations are IAK practices including the control and management of banana wilt disease, but the spacing aspect is MAP. This shows that there is conscious integration of IAK and MAP that needs to be pronounced and promoted. The spacing of mats and having few suckers enables them to produce big bunches that are that are on high demand and attract high prices.

This shows that integrating both MAP and IAK in banana production is an advantageous, it leads to production of big bunches, which enable the farmer to have more income compared to one who uses only IAK. This was further explained by the large percentage of respondents who were combining both. Through observation, one could easily see that a relatively fair number of banana plantation mats were spaced 3-4 meters apart though most plantations had mats

spaced between 2-3 meters. The spacing of 3-4 meters was mainly done by the relatively rich people in the area. This was shown by the nature of the home steads, roofs of the houses, and presence of water harvesting tanks, HEP and solar panels on the houses. One could easily deduce that those that were having aspects of integration in banana production were the well-off people in the community.

Growing of hybrid breed maize seeds in line and intercropping them with local beans or ground nuts and cassava was reported by 42 out of 102 (41.2 %) of the respondents. The respondents revealed that they were buying hybrid seeds and few had got them from OWC, but growing them in parallel lines using IAK practices such as opening the land using a hoe, weeding and harvesting.

Growing of hybrid maize seeds by broadcasting and intercropping them with local beans was reported by 46 out of 102 (45.1%) of the respondents. This little percentage was due to the fact that
hybrid maize seeds are susceptible to disease and grow well when there are plenty of rain and in the event when there are little rains or unexpected dry spell, they easily dry off, and the farmer losses. With favorable weather condition, it was revealed that they are able to harvest a lot of maize, however the approach of this aspect towards sustainable food security in the area is minimal.

5.2. Integration of IAK and MAP in Food Preservation and Storage

Activities Integrated in Food Preservation and Storage	*Frequency	%
Sun drying of beans and preserving them using lindane dust	21	20.6
IAK preserved beans, maize and ground nuts stored in synthetic sacks	81	79.4

Table 11: Showing Activities Integrated in Food Preservation and Storage
Source: Field Data 2017
**Multiple Responses*

Sun drying beans and preserving using lindane dust was reported 21 out of 102 (20.6%). Sun drying is an aspect of IAK while the use of lindane dust is MAP. The respondents revealed that they were sun drying beans on taplines, mats and on the bear ground. After sun drying, before storage they would put in lindane dust into beans so that they are not attacked by the bean weevils.

This explains why few respondents were using this method in the control of bean weevils an indicator that most of the respondents were using IAK. The failure by lindane dust to work may be a result of using expired or counterfeits since most people in the area could not tell if it was expired or counterfeit .

Storing locally preserved beans, maize and ground nuts in synthetic sacks was revealed by 81 out of 102 (79.4%). synthetic sacks commonly known as obudeya were found out to be the most used in storage of the produce in area of study. After sun drying and mixing the produce with IAK dust / pesticides or any method of preservation, they would put them in synthetic sacks and store them for future use or sell. The synthetic sacks though relatively expensive, they were found to be durable, convenient to store in and easy for transportation of the stored produce which revealed why a large number of respondents were using them. Through observation synthetic sacks were found in most shops in towns and trading centers an indicator that they are highly demanded in the area.

5.3. Challenges of Integration IAK and MAP towards Attaining Food Security in Isingiro District

The respondents were asked about the challenges of integrating IAK and MAP towards attaining sustainable hold food security and they revealed the following as presented in the table below:

Challenges of Integrating IAK and MAP	*Frequency	%
High cost for hiring a tractor	58	56.9
High costs of hybrid maize and beans seeds	65	63.7
Fake hybrid seeds	64	62.7
Hybrid seeds being easily attacked by pests and diseases and do not withstanding harsh weather/ climatic conditions.	53	51.9
Fake fertilizers	15	14.7
Small areas for crop cultivation	62	60.8
Poverty	67	65.7
Lack of recognition of IAK methods and local seeds	68	66.7

Table 12: Showing the Challenges of Integration IAK and MAP towards Attaining Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

According to table 19 above, 58 out 102 (56.9%) of respondents revealed a challenger of high cost for hiring a tractor. During the time of the study, the cost for using a tractor ranged from 500,000 – 3,000,000/ = Uganda shillings. In addition, one had to pay the operators some side money about 50,000/ = as a motivation to plough a big area. Most people in Isingiro District are peasant farmers and could not manage the high cost of a tractor hence its minimal use. Even the few that had used it, it was only used for ploughing and harrow only. But planting, wedding and harvesting were being done by people. This is in agreement with the study by Development Research and Training (2012) in Uganda that about 3.4 (95.8 %) out of 3.6 million agricultural house holders in Uganda still use the hoe as the main farm tool for cultivation.

The challenges of high cost of hybrid maize and bean seeds was mentioned by 65 out of 102 (63.7) %. of the respondents. This indicated that a relatively high percentage of respondents were aware the hybrid seeds, but the cost was high and few could afford to buy them season after season as they are not replanted. During the time of the study; the cost a kilogram of hybrid maize seeds ranged from 4000 – 5000/ = and beans 10,000 -15,000/ =.

The risk of buying fake seeds was revealed by 64 out of 102 (62.7%). The respondents revealed that some seeds on market are fake and at times fail to germinate which result into a loss. Or some germinate and others fail to germinate.

Hybrid seeds being easily attacked by pests and diseases and not withstanding harsh weather conditions was revealed by 53 out 102 (51.9%) of the respondents. It was found out during the study that hybrid seeds of both maize and beans were being attacked by numerous pests and diseases. Maize plants were being attacked by army worm pest and various diseases that led to the rooting of the stems and another disease that turned the leaves yellowish leading to poor harvest or no harvest. Beans were being attacked by various disease and pests too that turned their leaves yellowish, leading to the falling of flowers. They were also attacked by small ants that suck fluid from them. All these led to poor growth and harvests if any. Few people were able to spray them as the cost of the drugs to spray them was high and it was not only one kind of drug that would be needed. This explains why few were planting them.

Terrain as a challenge to integration was mentioned by 36 out of 102 (35.3%) of the respondents. Some parts of Isingiro District hilly like in Kabuyanda, and Kabimgo and the use of a tractor is not possible on a hilly terrain due to gradient of the land even if one has the capacity to use. In such areas most of the cultivation was in the broad unshaped valleys that were intensively cultivated through intercropping as a way of maximizing production from such land.

Fake fertilizers as another challenge to integration was mentioned by 15 out 102 (14.7%) of the respondents. The respondents revealed that not all fertilizers that are on market are genuine; some are counterfeits and do not work. The cost of fertilizers itself was high and when applied and fail to work it become a double loss to the farmers. This explains why few had applied than in their cultivation and explains why most people were using organic manure.

Poverty as a challenge to integration was mentioned by 67 out 102 (65.7%) of the respondents. It was revealed by respondents that they are poor and hard for them to combine IAK and MAP that are expensive. The people of Isingiro district are mainly peasant farmers with low income hence unable to combine IAK and MAP that are expensive such as the use of tractor, buying of hybrid seeds, sprays and fertilizers.This shows why majority of the people were not integrating IAK and MAP and why it was the relatively rich few who were integrating.

Lack of recognition of IAK practices and local seeds varieties challenge was mentioned by 68 out 103 (66.7%) of the respondents. It was revealed during the study that whereas IAK and local seeds have sustained rural households in food production they are not recognized in modern agricultural practices.

5.4. Benefits of Integrating IAK and MAP towards Attaining Food Security

The respondents were asked about the benefits of integrating IAK and MAP towards attaining sustainable hold food security and they revealed the following as presented in the table…below:

Benefits of Integration of IAK and MAP	*Frequency	%
Ploughing a big area and preparing for planting in short time using a tractor	64	62.7
Producing large harvests	88	86.3
Production of big bunches of matooke	68	66.7
Producing a variety crops through intercropping	63	61.8

Table 13: Showing the Benefits of Integrating IAK and MAP towards Attaining Food Security
Source: Field Data 2017
**Multiple Responses*

Ploughing a big area and preparing for planting in short time using a tractor was revealed by 64 out 102 (62.7%). This showed that people were aware of the advantage of using a tractor in land preparation compared to human labour, despite few people using it. Besides ploughing and harrowing a big area in a short time; it ploughs deep into the soil there by burying grasses into soil turning them into manure which contributes to better yields.

Another benefit of producing large harvests was mentioned by 88 out of 102 (86.3%) of the respondents. It was revealed during the study that those who were integrating IAK and MAP such as the use of tractor and growing of one crop on one garden such as maize or beans were producing large harvests that enabled then to have a reasonable amount for home consumption and the surplus for sale. As earlier on mentioned these were the relatively rich who even had relatively big areas of land. Production of big bunches of matooke commonly referred to as large was mentioned by 68 out 102 (66.7%) of the respondents. It was found out these bunches are on a high demand compared to medium and small bunches. As earlier on mentioned the big bunches costed between 10,000 -20,000/ = depend on the season. During the day

season they costed 7,000 - 10,000/= and during rainy season, they costed 10,000 - 20,000/= compared to the small / medium bunches produced by those that never integrated that costed 2,000 - 3,000 during the dry season and 4,000 - 5,000/= during the rainy season. In all seasons the one who integrated sold his / her matooke at a high price; translating to having high incomes. This explains why the homesteads of those who integrated in banana production were at a high standard compared to those who didn't integrate IAK and MAP in banana production. Another benefit was production of a variety of crops through intercropping was revealed by 62 out 102 (61.8%) of the respondents. It was revealed that growing of high breed seeds of maize on lines and intercropping them with local beans / ground nuts and cassava enabled them get relatively high harvest of food stuffs. It was further revealed in the study that with intercropping of high breed maize seeds with local beans and cassava, the maize plants were less attacked by pests. Thus, the people were found to be aware of the advantages of integrating IAK and MAP though hindered by a number of challenges. These included high cost of inputs, fake seeds, poverty and lack of recognition of IAK and local seed varieties towards food availability, accessibility, and utilization in rural households that have sustainable them for countries, though less recognized in modern food production strategies. An approach that recognize the IAK practice and local seeds could contributed greatly towards food availability, accessibility, utilization and stability in rural households in Isingiro district.

5.5. Strategies for Enhancing Integrating IAK into MAP For Sustainable Food Security in Isingiro District

Chambers (1983, 1994) points to the need for integrating both the knowledge of the local indigenous people with new development approaches to ensure local ownership and eventual sustainability. Chambers (1983) emphasize the need for the integration of this knowledge with modern scientific knowledge. He argues that the rural people's knowledge and scientific knowledge are complementary in their strengths and weaknesses and that when combined they may achieve what neither would alone. The respondents were asked about the strategies that can be put in place to enhance integration IAK into MAP for sustainable food security in Isingiro District. These are presented in the table below;

Strategy	*Frequency	%
Identification and documentation of IAK for integration	102	100
Growing indigenousseeds using MAP	64	62.7
Teaching it in schools	81	79.4
Advocacy and awareness raising	66	64.7
Control of fake seeds, fertilizers and pesticides	42	41.2
Reducing the cost of in puts	38	37.3
Improving agricultural extension work	21	20.6
Restructuring OWC	17	16.6
Promotion of use of organic manure	54	52.9
Government putting a strategy or a plan for integration	34	33.3

Table 14: Showing Strategies to Integrate IAK into MAP for Sustainable Food Security in Isingiro District
Source: Field Data 2017
**Multiple Responses*

5.5.1. Identification and Documentation of IAK for Integration

According to the table above, all the 102 (100%) respondents, revealed the need for identifying and documentation of IAK due to its importance towards sustainable food security. It is after identification and documentation that the process of integration can be done systematically(Vinita et al, 2017 and Abiola,et al 2011

This showed that some government workers in the field of development appreciate the value and importance of IAK towards food production despite lack of support in MAP. The above views, are supported by Akullo (2007) who state that the indigenous knowledge of the people is very effective in meeting their food requirements, effective in areas of soil enrichment, land clearing, sowing, harvesting, weeding and mound/ridge making. She further states that their mixed farming, mixed cropping, crop rotation and shifting cultivation helps tremendously in their bumper harvest. One of the best approaches to preservation of traditional knowledge is documentation in some permanent form for public accessibility in special libraries (Lwoga, et al., 2010; Nakata& Langton (2005) emphasizes that libraries must consider indigenous knowledge not simply as part of a historical archive, but a contemporary body of relevant knowledge.

Research has shown that IAK and the entire IK is preserved in the memories of the holders. (Abiola et al 2011; Haumba, 2015; Aluma et al., 2015; Oluwaseye and Adebola, 2017 and Vinita 2017).

There is a possibility of its fading due to memory lapses and death. IAK is gradually disappearing in most African countries including Uganda without any tangible efforts to recognize or manage it (Lwoga, et al., 2010). Kumar (2010) attributes this to the fact that oral paths are being blocked and people are no longer staying in homogenous community blocks. Atwooki, (2010) observed that one of the bottlenecks for utilization of IAK is access to relevant and usable IAK for the diverse stakeholders in the agricultural sector including farmers. Documenting the existing IAK practices is key towards its utilization and integration. Tsiko (2004) states that documenting IAK is critical as it is being marginalized by high culture resulting in assimilation and cultural genocide. With due consideration to intellectual property rights, it is imperative to document this knowledge that has practical value towards food security and sustainable development (SDG, UN, 2015). Finally, modern technology is an important aspect in identification and documentation IAK because Information and Communication Technologies (ICT's) are free from the fetters of time and space (Nakata and Langton, 2005). The identification and documentation will create a database for people seeking IAK information as regards the type, form and

applicability, can be used to stake the claim of communities or individuals for royalty payments for the transfer of technology, educational purpose and for effective integration with MAP.

5.5.2. Growing Indigenous Seeds Using Modern Agricultural Practices

Growing indigenous seeds using MAP was revealed by 64 out of 102 (62.7%) respondents. This showed that people prefer indigenous seeds over hybrid / GM seeds. Furthermore, it showed what aspects of MAP that are preferred compared to IAK. Seeds are the most basic inputs for any food security system as they ensure quality and quantity of produce as well as continuity of crop varieties.

Small scale farmers form over 95% of the farmers in Uganda and have control over their seeds since time immemorial, however this trend is slowly changing. Currently, there are two categories of seed supply systems in Uganda; the formal and informal seed sector. The formal seed supply system involves the seed production and certification processes. The seeds produced by the formal seed sector is of high genetic and purity value, but contributing about 20% to the seed supply system (PELUM Uganda 2012). On the other hand, there is the informal seed supply system contributing more than 80% of the seed supply. These are local seeds that people select and store for planting in the next season. The preference of local seeds is not only in Uganda, according to The African Center for Sustainable Ecosystem and Societies (2014), a peasant lady farmer in Zimbabwe who had grown both types of maize had this to say:

Hybrid maize varieties mature early, can produce high yields in good seasons, compared to traditional varieties. But in a bad season, it is mostly the traditional varieties that give me a good yield. Indigenous seeds are also preferred in Kenya, Kibui (2017) noted that experts advised Kenya to come up with policies that will secure the sovereignty of her seeds in a bid to enhance food security and conserve the indigenous seeds variety. That systems should also be put in place to identify and document all Kenyan seed varieties to protect sovereignty, history and boost food security. Incorporating indigenous knowledge into planning allows culture and belief systems to direct the way in which information is collected and used. As much as farmers are encouraged to grow hybrid crop varieties due to environmental challenges, they should also be encouraged to complement these with indigenous varieties which have high nutrition value, long storage period and can easily be managed by low income farmers. Communities should share knowledge, lessons and experiences in the farming of indigenous crops, manure production and seed multiplication and storage. The preference of indigenous seeds is thus based on the following qualities: they are easy to get, easy to grow, require not external in puts like agro-chemicals, cultivation practices are adapted to locally available resources, more nutritious, they are on a high demand and cultivation is in line with sustainable agriculture and are continually adapted to meet changing circumstances.

5.5.3. Inclusion in School Curriculum

Teaching it in schools was stated by 81 out of 102 (79.4%) of the respondents. The respondents revealed that IAK is important towards food security but not being taught to the young especially those in schools where it is not in the school curriculum. Since they stay with their parents for a short time; leave a lone those who stay in urban centers where there is limited application.

The inclusion of IAK in institutions curriculum like MAP will enable the students to know it as another form of a global knowledge system. It will also go a long way to the extent that the CDOs and Agricultural extension staff will be appreciating it rather than despising it since they will have studied it and be able to apply it in extension service with MAP, thus enabling its integration process. The teaching it will enable the students to appreciate indigenous ways of living and using resources sustainably, understand the role of 'modern' education in undermining indigenous knowledge and practices, identify opportunities, develop procedures for integrating IAK into MAP for sustainable food security. Lastly, there is need for intensive and exhaustive research on IK as a global knowledge system in order to make agriculture and rural development strategies sustainable as presented in Sustainable Development Goals 1 and 2 (UN,SDG, 2014).

5.5.4. Advocacy and Awareness Rising

Advocacy and awareness raising as a strategy towards integrating IAK into MAP was stated by 66 out of 102 (64.7%) of the respondents. The respondents revealed that there is a need to promote awareness among the people on importance and value of IAK towards food production, storage, consumption and seed selection. They further observed that most of the food if not all in the district is produced through IAK which is being despised and under looked by the educated and rich; despised as outdated and traditional, presenting it as knowledge that is old. IK is dynamic and involves actual participation of the local communities at the grassroots which eventually contributes to the sustainability of the development interventions and sustainable food security at rural household level if well handled in an integrated approach. Advocacy and awareness raising will lead to sensitization of people on the importance of IAK towards food availability, accessibility, utilization and stability at rural house level. It will then be appreciated and treasured by both the educated and non-educated in the current food production system It was further revealed in the study that another way towards its integration with MAP would be to identify model farmers using it and producing high yields like the growing of bananas, beans, maize and cassava which are among the staple foods and cash crops in the area. When model farmers are identified and popularized in the area, the young, educated and the rich will start appreciating, hence its usage, recognition, promotion and eventually incorporating it into MAP; thus, being appreciated as another form knowledge that can supplement modern science.

5.5.5. Government Putting Up A Strategy or A Plan For Integration of IAK With MAP

Government putting up a strategy or an action plan for its integration with MAP was mentioned by 34 out of 102 (33.3%) of the respondents. The respondents who revealed this strategy were mainly the local leaders, civil servants and those with high formal education. They observed that for integration, the government has to come in and be in the lead since it's the one that enacts policies and plans of development action.

Government putting up an action plan or strategic frame work will be in line with SDG 2 which centers on zero hunger, promotion of peasant agricultural farming systems, resilient agriculture, sustainable food security and development (UN,SDG, 2015). With the action plan in place, the government will be able to put IAK into agricultural policy frame work, extension policies and all agricultural development agendas which will result into effective and efficient integration of both knowledge systems. When this is done, it is hope that sustainable food security will be realized in Uganda and Isingiro District in particular at rural household levels.

The action plan will enhance the capture, documentation, storage, validation and dissemination leading to the development of a data base of IAK practices. These are some of the principle steps that are lacking in Uganda which are necessary in the process of integrating IAK into MAP. The plan will further facilitate the understanding of the importance, value and inform policy development and implementation. A frame work for integrating IAK into MAP will also be developed and implemented. Warren (1990) one of the foremost writers on indigenous knowledge, notes that it is an important natural resource that can facilitate the development process in cost-effective, participatory and sustainable ways. And that it has value not only for the culture in which it evolves but also for scientists and planners striving to improve conditions in rural localities.

Arguing along similar lines, Pretty (1995) points that agriculture can only be persistent and sustainable when resource-conserving technologies are developed and used by local institutions and groups, who are supported by external research, extension and development institutions acting in an enabling way. For sustainable agriculture to spread, the wider policy environment must too be enabling.

5.5.6. Proposed Frame Work for Integrating IAK into MAP

The study has revealed that neither IAK nor MAP alone is a panacea for sustainable rural house hold food security. IAK and MAP are complementary in their strength and weakness and their incorporation leads to a better approach to food security at rural household level. The proposed frame work for integration of IAK and MAP showed below will facilitate understanding, documentation, advocacy and acceptance of IAK paving way for its integration into MAP. The integration of both IAK and MAP will lead to knowledge broadening, knowledge reconfiguration and synthesis of knowledge. The proposed frame work has six steps to be followed and starts with participatory research with the community; analyzing the challenges to sustainable food security as the first step. This will be followed by analysis of both IAK and MAP for sustainable food security system in step two. The relationship between the two is not linear, to and flow relationship. The third step, involves the identification of both IAK and MAP best practices for cultivation, management of gardens and banana plantations, harvesting, preservation and storage leading to development of integrated strategies and approach for sustainable food security achieved at step four. This leads sustainable food production systems having enough to eat and surplus for sale in step five. This leads to sustainable food security at rural house hold level attained in step six as shown in the proposed frame work for integrating IAK and MAP presented below.

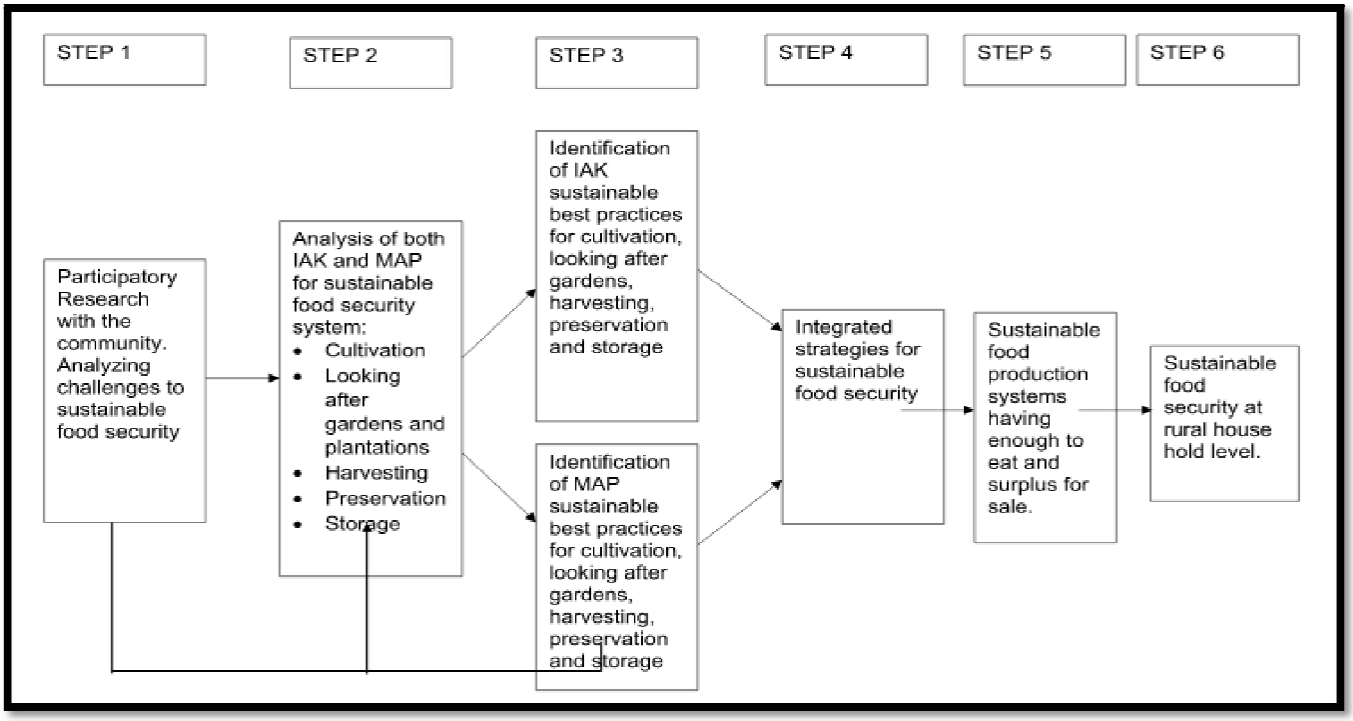

Figure 1: Proposed Frame Work for Integrating IAK into MAP for Sustainable Food Security in Uganda

5.6. Conclusion

There is a conscious integration of IAK and MAP towards sustainable rural household food security in the district. The aspects of integration were found in all areas of food production system but at varying degrees with IAK being predominant. The use of a tractor was only used by few in land preparation and rest of the work such as planting, weeding and harvesting by human labour. Growing of indigenous banana varieties but applying MAP in the management was found extremely advantageous. The growing of hybrid breed maize and intercropping them with local beans or ground nuts and cassava has showed an innovation against army worm pest control. Sun drying was found out to be the most used method in preserving food while synthetic sacks were the most used in storage. The challenges to integration included the high cost of MAP in puts, easy attack of diseases, lack of replanting, poverty and lack of IAK recognition. The need for identification and documentation of IAK, advocacy and awareness raising, reduction in costs of MAP inputs and putting up a strategy for integrating both IAK and MAP were found to be the main strategies towards integration

6. General Conclusion

It is clear that neither IAK nor MAP alone is a panacea towards sustainable food security. Sustainable food security makes the best use of nature's goods and services as functional inputs. It integrates natural and regenerative processes such as nutrient recycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes. It reduces the use of non-renewable inputs; pesticides and fertilizers that damage the environment. IAK and MAP are complementary in their strength and weakness and their incorporation leads to sustainable food security. The development of an action plan and a frame work for integration of IAK and MAP will facilitate understanding, documentation, advocacy and acceptance of IAK leading to its integration into MAP; which will lead to knowledge broadening, reconfiguration and synthesis for enhancement of sustainable food security in Uganda.

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