East African Community
Lake Victoria Basin Commission

scaleWAYS

Scaling out resilient Water and Agricultural Systems

Prepared by VIRED International

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About the study

This scoping study was conducted by the Victoria Institute for Research on Environment and Development, Kenya. It provides the rice related research of the consultancy services for the 'Scoping Study on the Status and Development Ambitions for Rice Cultivation and Fodder Production in the Extended Lake Victoria Basin (e-LVB) in Burundi, Kenya, Rwanda, Tanzania and Uganda' (REOI - LVBC/SVS092).

The study was performed under the leadership of *Prof J.B. Okeyo-Owuor* and the scoping study team members of the partner states including:
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The scoping study provides key input for 'Scaling out resilient Water and Agricultural Systems (ScaleWAYs)', a collaborative research and implementation project between the International Institute for Applied Systems Analysis (IIASA), the Lake Victoria Basin Commission (LVBC) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The geographic focus of ScaleWAYs is in the extended Lake Victoria Basin (e-LVB), which encompasses the headwaters of the River Nile to its outlet at Laropi, Uganda. The e-LVB is an international transboundary watershed including Burundi, Kenya, Rwanda, The United Republic of Tanzania, and Uganda. The ScaleWAYs stakeholder-based approach has identified two production systems of particular relevance for development and sustainability in the e-LVB, namely rice systems and fodder/livestock systems. This report presents results of the Scoping study of fodder production systems in the main five countries of the e-LVB.

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1 INTRODUCTION

1.1 Overview

Rice is one of the most important food crops in the fight against hunger in Africa. Due to its importance, international partners and Pan-African initiatives have increased their interest in rice research and development for the benefit of the livelihoods of communities living mainly in sub-Saharan Africa. They include the Food and Agriculture Organization of the United Nations (FAO), the New Partnership for Africa's Development (NEPAD), the Comprehensive Africa Agriculture Development Programme (CAADP), the Forum for Agricultural Research in Africa (FARA), the Eastern and Central African Rice Research Network (ECARRN), the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), and the East African Community (EAC). This section therefore provides an introductory overview on among others the status, approaches and ambitions for rice production within the Lake Victoria Basin.

1.2 The Status of Rice Production in the e-LVB

This section analyzes the regional production systems and provides a comparative analysis between the ecologies of different rice growing areas in the 5 partner states namely Burundi, Kenya, Rwanda, Tanzania and Uganda. It provides specific elements and practices on rice-based production system and also gives a broader understanding of the whole system where rice production plays an important role. The study focused on areas in the e-LVB where rice is grown and considers the various production systems in each country. Based on agreements at the Researchers workshop held in Entebbe on 26-29 February 2020, for each country a detailed analysis has been presented for selected potential intensification and upscaling rice growing schemes.

In Burundi, the governmental departments dealing with rice production, water management and marketing are the directorate responsible for IWRM and the provincial offices in charge of environment, agriculture, and livestock. Additional relevant institutes include the Burundian Agronomic Scientific Institute (ISABU) for research, the National Office for seed control and certification (ONCCS) and seed selection and the International Rice Research Institute (IRRI). Rice growing practices in Burundi are similar to that in Rwanda. In Rwanda rice production is guided by Rwanda's Vision 2050, the National Agricultural Policy, Strategic Plan for Agriculture Transformation (2018 – 2024), Land Use Consolidation Policy and implemented through the Ministry of Agriculture, as part of the Crop Intensification Program (CIP) among others. The country received good technical and financial assistance from international agencies such as JICA, UN-FAO, World Bank, IFAD and One Acre Fund. Unlike other countries rice production systems in Rwanda, apply farm inputs to increase productivity e.g. improved seeds, both organic and inorganic fertilisers. Irrigation water is managed by government and societies and is not a limiting factor for rice growing. Rice is grown in 2 seasons, i.e. Season A and B.

In Kenya, the Ministry of Agriculture, Livestock and Fisheries, the Ministry of Water and Irrigation, The National Irrigation Board (NIB), Kenya Agricultural and Livestock Research Organization (KALRO) are concerned with rice research and production. Except in the NIB schemes, many farmers in non-NIB schemes in LVB-Kenya rarely use farm inputs such as fertilizers, herbicides, improved seeds, etc mainly due to their scarcity at the time of planting. In

LVB-Kenya, rice is grown in only one rice growing season. Farmers grow different rice varieties with seeds obtained from NIB, neighbouring farmers or own store. Land preparation are either by hand, ox-ploughs and or tractors and the crop is grown by only smallscale farmers in average farm sizes of 0.5-1.5 acres. Basin/flood irrigation is popular in the 42 sub-schemes of South-West Kano Irrigation Scheme and common varieties grown are largely not aromatic and aromatic basmati in only a few schemes. Seedbed preparation and other agronomic practices in the LBV-Kenya is similarly to that found in other smallscale farming systems in the partner states. The amount of water available for irrigation depend on rains, river follow and season in all the 5 countries and fluctuations in irrigation water causes variations in crop growth and yield. In all the smallscale farms in LVB, the schemes are divided into blocks of 10-15 farmers who receive water at different times of the year to avoid water use conflict and shortage during critical growth time except in areas where rice is grown under rainfed conditions. Rice grains harvested are bought at the farm gate price by millers or middlemen.

Farmers suffer numerous constraints many of which are similar in the entire region. In Tanzania the Ministry of Agriculture, Food Security and Cooperatives (MAFC), Agricultural Research Institutes (ARI) and Agricultural Seed Agency (ASA) as well as IRRI are the key players in promoting rice production. National Food Reserve Agency (NFRA) and Alliance for Green Revolution in Africa (AGRA) also support rice growers. Most rice (74% area) grown is upland and cultivated by smallholders. Unlike other partner states, rice is also grown by some large-scale farmers. The Government subsidizes fertilizers via a voucher scheme which mainly benefit large farmers more than smallholders. The open market farming system and contract farming are common in the rice growing areas and depends mainly on the type of water system. However, most rice is grown under rainfed, irrigated and/or supplemental irrigation production systems in most rice growing areas in LVB. The study found that in LVB-TZ there is sufficient water for rice growing which provides a great potential for upscaling and intensifying rice production once the major challenges are addressed in the rice growing parts of Mara Region under study.

The ability and willingness by farmers to use improved seed variety and quality pesticides as appropriate can greatly enhance rice production and yields. Farmers who are members of rice schemes or co-operative can benefit greatly in terms of infrastructure for value addition rice mills, warehouses, and financial access.

In Uganda, rice growing is relatively new to most farmers since production started to increase only in the 1970s after the government established Kibimba, Doho and Olweny rice irrigation schemes. The increasing rate of rural-urban migration caused by the high population rate, increasing urbanization and change in food habits have favoured rice growing in the country. In Uganda rice is grown under three main ecologies, namely rainfed lowland, irrigated lowland (paddy rice) and rainfed upland. The rainfed lowland ecology is mostly found at the fringes of wetlands where irrigation infrastructure is already developed but recent presidential directives in favour of wetland protection is bound to deter rice growing here.

This scoping study focused on the Doho rice scheme, formerly a wetland, but converted to irrigated rice production and covering 2500 acres of land. The Doho scheme involves 4000 small scale farmers each operating 0.25 to 3 acres land (ave. 0.5acre) organized in 11 blocks where only rice is grown and the cropping calendar depends on adequate water and the onset of rains. The common rice varieties grown include all non-aromatic varieties and on average the scheme produces some 7200 tonnes of unmilled rice (or 4700 tonnes of milled rice). In Doho scheme, only a few farmers apply inorganic fertilizers, especially DAP, UREA and NPK to ensure proper

crop growth and increased yields. These operations are similar to the practices in Kenya, Tanzania, Rwanda and Burundi.

1.3 Biophysical conditions needed for rice intensification

The biophysical requirements for successful growing and scaling of rice are relatively similar in the rice growing areas in the partner states. There should be appropriate ecologies for growing the crop either under upland and or irrigated conditions. In the 5 partner states, rice is mainly grown in lowlands and valley bottoms where flood irrigation is used. There are also opportunities for rainfed rice growing in the higher elevations in the region. In Burundi, Rwanda and Uganda paddy rice is mainly grown in reclaimed wetland areas while in the Kenyan part of e-LVB, the common practice is flood irrigation in flood plains of Kano along river Nyando, Budalangi along River Nzoia, Maugo along River Tende and the lower plains of River Kuja. The upland varieties are also grown under rainfed conditions but in fewer areas. Tanzania has various ecologies suitable for rice growing within LVB. Of interest to this study are the districts located in Mara region, which have shown great potential for expanding and intensifying rice production in the country since water is not a limiting factor for rice growing and Tanzania Government is keen to expand and intensify rice production. Uganda's rice is grown in reclaimed wetlands areas at Kibimba, Doho and Olweny rice irrigation schemes. But with the recent Presidential directive stopping rice cultivation in wetlands their fate hang in the balance.

Soil fertility and adequate water supply are the key factors in rice production in the LVB. Most soils in rice growing areas are black cotton soil (clay soil with a high content of montmorillenite) and alluvial (flat plains crated by sediment deposition) in nature and are not sufficiently fertile for intensive rice production. Nevertheless many farmers in the region except in Burundi and Rwanda do not use organic or inorganic fertilizers during the crop growth. Some of the five partner states have good and effective cooperative societies which usually provid farmers with inputs to increase rice yields such as fertilizers. In Kenya and Uganda most small-scale farmers hardly use farm inputs such as fertilizers to improve soil fertility and only a few of them apply DAP (Di-ammonium Phosphate) or UREA as top dressing. Compared to rice intensification systems, the current rice yields from small scale farmers in the region are quite low due to low use of farm inputs.

1.4 Infrastructure, knowledge and use of intensification approaches

Improving access to infrastructure, knowledge and use of intensification approaches can increase rice productivity and ensuring resilience of these systems. According to Allen and Sander, (2019). The use of AWD practice works to improve other important elements of the agricultural systems, such as soil health, while reducing adverse externalities of rice production. It has positive effects on rice crop phenology and on agro-ecosystem rice fields (Thakur et al., 2018; Uphoff, 2003) although it works better inwell prepared prepared fields, finer textured soils, moderately acidic pH, and high soil organic carbon (Carrijo et al., 2017). In Uganda it was reported that AWD success depend on rice variety used and appropriately selected seeds to maintain productivity compared with continuous flooding practices (Awio et al., 2015).

Farmers in the e-LVB rarely use any crop intensification techniques, thus a good starting area for scaling up and further research. Critical assessment is required to demonstrate the feasibility of

employing and promoting the proposed rice intensification practices to ensure expected results and acceptability by farmers. Using good and high yielding rice varieties that are adapted to the biophysical conditions of the region, resilient to weather variability and extremes, and resistant to pest/diseases attacks is also key to any rice production intensification. Till now, several hundred cultivars have been developed and released to rice farmers with some advantages and disadvantages worth considering when selecting rice seeds and making farmers aware (Somado et al., 2008 and Kikuta *et al*., 2017). Land should be properly prepared before crop establishment to obtain the potential benefits of SRI. Evidence from Tanzania showed that levelling and bunding of plots can increase yields by 40% alone and increase the use efficiency of fertilisers (Kwesiga *et al*., 2019).

In some selected scoping study areas such as in (South West Kano Rice zIrrigation Scheme (SWKRIS), farmers make small bands because it requires a lot of expensive labour, time and knowledge. Where farmers belong to a society in Tanzania, the fertilizers are subsidized. In the SWKIS in Kisumu County, some farmers buy from the Natinoal Irrigatin Board (NIB) or local agrovet dealers but apply at varied levels. Although application of organic manure is crucial especially in poor soils, we find that no farmer applies them even in adequate quantities to make a difference in rice yields. Farmers in the selected scoping study sites prefer using manure in other crops but not rice. In fact, cost-benefit studies have shown that the value cost ratio of applying mineral fertiliser in Sub Saharan Africa is considerably lower compared to Asia because fertiliser is more expensive and less accessible (Tsujimoto et al., 2019). Also, excessive use of inorganic fertilisers near the Lake Victoria has adverse effects on the natural ecosystem of the lake and the associated wetlands by causing eutrophication (LVBC and GRID-Arendal, 2017). Weeds can cause yields losses of 30-70% losses in transplanted lowland rice and 48-100% in upland rice (Rodenburg and Johnson, 2013). We found that farmers put much of their efforts in weeding rice to avoid this calamity especially in irrigated rice.

In the case of Sustainable Rice Intensification (SRI), weeds are an issue due to wide spacing of rice seedlings during transplanting and rice takes longer duration to close its canopy. Farmers prefer hand weeding despite its high costs. A study on the adoption of SRI in Kenya showed that it required 30% more labour for weeding in the first year but reduced to 15% in the second year when mechanical push-weeders were used (Ndiiri et al., 2013). Our scoping study areas in Kenya, Uganda and Tanzania show that mechanical push weeders are still at demonstration stage. Farmers also argue that the weeders are fragile and breakdown fast making it difficult for repair by untrained “jua kali” artisans. Additional limitations to mechanization include small farm sizes and poor access to equipment.

1.5 The key factors for Rice Growing and intensification

In the LVB region, rice is mostly produced in near abundant and reliable water supply such as in flood plains, wetland ecosystems, riverine, valley bottoms and upland ecologies. Fortunately, such ecosystems that suit rice production exist within the e-LVB in all the riparian partner states.

For rice intensification to be successful, various requirements must be considered. These mainly revolve around quality farm inputs necessary for increased productivity such as mechanized technologies, certified high yielding seed varieties with favourable qualities such as tolerant/resistant to drought, pest and disease. Weed control and judicious use of fertilizers as well as proper water management are key operation in scaling up and intensification operation in the region.

1.6 Policy and institutional arrangements for scaling and intensification of rice production

Governance and Political elements/framework conditions

The partner states in the LVB are political organizations run and coordinated by elected leadership and policies. Much as each country seeks self-sufficient in rice production for domestic use and exports most of the national decisions are politically motivated and can be skewed in favour of the political party in power as well as factor affecting regional integration. For instance, Burundi is linked to East Africa Community by its relief and its climate but is land locked between Tanzania, the DRC and Rwanda. After the past two years of recession Burundi's economy is recovering slowly from a 2017 growth rate of 0.5% to 1.6% in 2018 but this growth might have also been affected negatively by the COVOD-19, flooding and other factors.

In Kenya much attention in rice production and intensification approaches have been largely limited to Central Kenya, where Mwea Rice Scheme plays a key role compared to the schemes in the LVB-Kenya. Farmers interviewed observed that the political inclination towards central Kenya creates bias in favour of this region in terms of government support compared to LVB region. Recently, Kenya has decentralized its political management through establishing Counties. The South-West Kano Rice Irrigation Scheme (SWKRIS), the selected area for this scoping study is located in Kisumu County in the LVB has the advantage of being closer to the government (NIB) supported Ahero Pilot and West Kano Irrigation Schemes.

According to farmers in the SWKRIS they benefit less from the NIB supported farmers and cite political expediency for this. Locally the government of Kisumu County is yet to get a grip that supports the rice growers in WKRIS and associated areas citing lack of budgetary provision. At the scheme level some politics are also in play especially with local leaders fronting their supporters to be elected to scheme leadership positions causing distractions and lowering productivity. The Rwanda government has a strong political good will and drive to increase rice production in the country. The existing institutional structure support the scaling and intensification of rice production both in lowland irrigated and upland rainfed ecologies.

The rice schemes have good set of laws and procedures constitution and benefit from their various revenue sources. However, it was observed that at some point there exists political interference from political leaders—especially on water use and management. In Uganda some actions by the government leadership are interpreted as political interference. For instance, when

the President made a policy directive that smallholder rice farmers should stop growing rice in wetlands as a wetland protection measure. In recent years, the President has warned and given eviction directives to encroachers on wetland areas and in May 2018, directed farmers to stop using wetlands to grow rice urging them to grow upland rice. On April 22nd, 2020, the President directed the Minister for Water and Environment to evict all encroachers on wetlands, lake shorelines, riverbanks and government forest immediately. This situation made Uganda to initiate developing a new NRDS for the period of 2020 to 2030 effective 2019.

1.7 Practices and production system options for intensification of rice production

Production and consumption trend of rice in East Africa

The importance of rice as a food and cash crop, while varying in degree amongst East African countries (EAC), is well established and increasing. Overall, rice can be considered the second most important staple food consumed especially in urban centers. Tanzania dominates rice production contributing over 80% of EAC rice production. While all EAC countries have increased their production in the past decade, Tanzania's growth from 1.3 million tons (2009-11) to a current 2.08 million tons (2017-19) was most pronounced (FAOSTAT). Rice is mainly grown by small scale farmers. It serves both as a food staple and as a cash crop. Rice generates an average annual income of USD 550 per household, contributes to food security and is a major employment sector. EAC countries import rice, mainly from Asian countries to meet the high demands especially of aromatic rice. Changing taste and diets come along urbanisation and higher incomes causing increasing demand for rice. Tanzania stands out as becoming largely rice self-sufficient since 2014. Trade within the EAC region also plays a significant role in covering national demands.

Improving production of rice in LVB

The scoping study found that rice farming practices vary with partner state and scheme. Although yields are generally low because of the constraining factors described above there exist great potential to increase rice productivity in EAC. The potentials of rice growing areas is not yet fully exploited. But more importantly, the use of improved agricultural practices -especially water management, application of nutrients and organic matter to soil, and use of appropriate rice varieties- can contribute significantly to reduce yield gaps and combat adverse effects of climate variability and extremes (van Oort and Zwart, 2018). Since there exist various approaches to increase rice productivity, they can be tested and scaled in the studied areas such as Nyavyamo in Rwanda and Burundi, KWKRS in Kenya, Mara region in Tanzania and Doho in Uganda. While doing this, there is also a need to enhance the marketing network to ensure that farmers gain from their rice produce. In the rice producing areas of the e-LVB, the idea of testing and scaling the good practices in the use of the "System of Rice Intensification" (SRI) approach as observed in this scoping study is recommended. It is worth noting that there are several success cases in implementing SIR in Dodoma Tanzania, in Rwanda, Burundi and Mwea in Kenya as well as many rice growing countries in the world. The intensification options suggested by

Styger and Uphoff (2016) for Sustainable Rice Intensification (SRI) offer a set of viable practices to increase on-farm rice productivity. It is therefore proposed that rice intensification practices in the e-LVB are based on:

- ✓ Early and proper land preparation- preferably mechanized.
- ✓ Proper bunding and levelling of farmland to enhance uniform irrigation water distribution and minimize water loss during the growing season.
- ✓ Selecting and using high yielding and certified rice seed varieties
- ✓ Seed germination testing and early establishment of healthy plants by first soaking to prompt germination of health plants
- ✓ Use good spacing at transplanting to reduce overcrowding and competition between the transplanted seedlings.
- ✓ Testing soil nutrients levels during or before land preparation and plough under on farm organic matter and avoid burning rice stubbles in the field. Note organic manure is rather scarce and may not be available in good quantities for application in rice fields.
- ✓ Apply good water management practices such as alternate wedding and drying methods while avoiding flooding and water stress situations. Try using alternate wetting and drying (AWD) irrigation practice.
- ✓ Transplant seedlings in lines/rows to ease weeding by hand or mechanized appliances.
- ✓ Keep the field clean of weeds and weed 2-3 times to reduce competition by weeds. When available and based on soil suitability use small mechanical weeders between the rows.

1.8 Gender issues and related conditions for rice intensification

The adoption of scalable intensification practices of rice farming is further linked to social and societal aspects. Rice production in LVB is a labour-intensive activity and traditionally involves all members of the household at all the stages of production and marketing. Traditionally all the field operations were left to men except for harvesting and processing the produce. But with rice commercialization trends, most activities engage men, women, and youths. In this scoping study, the role of gender along the rice value chain beyond the levels of household involvement were examined. Further, changes from traditional to rice intensification practices are social processes in which farmers within a community or organisation depend on each other as well as on external driver and enablers (Styger and Uphoff September/2016).

The study shows that most (70%) in Kenya, Tanzania and Uganda would like to improve agronomic practices and yields in their rice farms, but they require financial and technical and training assistance as well as inputs. Similar position was also taken by farmers in Rwanda and Burundi who have better assistance from the government and development partners. This position is enhanced with higher levels of education of the household heads and the fact that youths and women are increasingly getting interested and involved in rice production and other

profitable value chain stage. According to Bont (2018) breaking established patterns of rice cultivations, adopting intensification and irrigation practices and fostering innovation is highly dependent on farmers gaining new knowledge and learning. Therefore, Styger and Uphoff (2016) observes that SRI approach requires farmer training over a period of three cropping seasons where the first season is characterized by demonstrations and confidence building, the second season by gaining technical proficiency and, the third season by expanding and scaling up of the practice. Additionally, households with younger and more educated household heads and those with good access to water resources are more likely to adopt practices such as bunds and planting in rows (Kijima et al. 2012).

Although farmers are experts on their own, they can act as principal agents of change and disseminate innovation if adequately trained (Meijer et al. 2015). Farmer linkages also serves to promote cultural acceptance and induce adoption of new technologies such as SRI (Kananyoro et al. 2013). Good farmer organisations, such as cooperatives, play an important role in the adoption and scaling of sustainable intensification practices. Some of these were found in the 5 partner states in the e-LVB. Indeed, farmer-led irrigation development has supported both the intensification and commercialization of agriculture in Tanzania (Bont 2018). According to Nabahungu and Visser (2011) much labour is required especially during weeding, harvesting. In general men are often involved in high income generating activities and women in lower income generating activities or activities concerning food security. However, the study observed that this position has changed dramatically as more women and youths now engage in even more profitable rice enterprises compared to men.

1.9 Rice Production system options for intensification

The literature study on intensification practices in rice production shed light on many interesting issues that can be targeted within the ScaleWAYS project from a biophysical, economic and political economy perspective. The demand for rice is increasing in the East African countries (EAC) and it has also been argued that the export market for rice in EAC will further grow leading to significant potential for intensification of rice production through various practices including soil improvements and with better infrastructure and access to markets as well as finance. Further, improving soil fertility, proper water management and the use of improved seeds will enhance better rice intensification and scaling and further increase yields. In the case of irrigation water management, alternate wetting and drying (AWD) and controlled irrigation is essential to increase resilience to climate variability and extremes, but installation and management of irrigation infrastructure as well as extension services are necessary.

Further, the cooperation of actors and institutions is essential in the use of inputs. Therefore, extension services, access to regulated markets, and regulatory institutions are necessary to facilitate the successful scaling of such practices. Several underlying causes for the low use of improved seeds have been reported. For example, farmers are reluctant to invest in improved seeds as the cost of income from rice is unpredictable. There are some constraints that relate to

the economic, political and societal scale which currently prevent some innovations from being widely adopted by rice farmers in the region. There is however a multitude of possible solutions and pathways towards the scaling of sustainable intensification practices in rice production, as well as the need for further interdisciplinary research into these and related issues.

2 BURUNDI

2.1 Geographic location and demography

Located in the heart of Africa, Burundi is linked to Central Africa by its history and East Africa by its relief and its climate. It is situated between the meridians 28 ° 50' and 30 ° 53' east longitude and the parallels 2 45' and 4 ° 26' south latitude. The country is landlocked and is surrounded by Tanzania to the east and south, the Democratic Republic of the Congo (DRC) to the west, and Rwanda in the north. The North Corridor road connecting Bujumbura (Burundi) - Kigali (Rwanda) -Kampala (Uganda) -Mombasa (Kenya) is the primary means of transport while the central corridor road starts from Bujumbura-Kobero (Tanzania) - Dodoma (Tanzania) -Dar-es-Salaam (Tanzania). There is also the East corridor (a mixed 'rail-sea,' i.e., Bujumbura-Kigoma (Tanzania) by Lake Tanganyika; then Tabora-Dar-Es-Salaam (Tanzania) by rail. There is also the South corridor from Bujumbura- Mpulungu (Zambia) –Mozambique, which is the shortest but least used mixed 'maritime-earthly' route.

The population of Burundi is currently estimated at around 12 million and continues to grow at a rate of 2.4% and a fertility rate of 5.5 children per woman. The consequences of this situation include a high poverty level currently estimated at 74.7% and malnutrition rate of 60%, placing Burundi among the five poorest and with a high unemployment rate countries in the world. Burundi is also one of the most densely populated countries in Africa, with 470 inhabitants per km². Its economy, mostly dependent on agriculture, which employs most (80%) of the population, even with scarce arable land. Burundi's economy was recovering slowly and had a growth rate of 1.6% in 2018 against 0.5% in 2017, after two consecutive years of recession in 2015 (-3.9%) and 2016 (-0.6 %). This fragile recovery remains below the 4.2% recorded from 2004 to 2014 and due to numerous challenges such as lack of budgetary resources to finance public investments, a persistent shortage of foreign exchange with the decline in international reserves, vulnerability in the financial sector, the increase in fiscal and current account deficits and declining foreign exchange market (Burundi Institute of Statistics and Economic Studies (ISTEEBU, Report 2019).

2.2 General policies on Agricultural Production in Burundi

The main policy documents guiding agricultural development in Burundi are:
Main Documents

- ✓ Burundi vision 2025
- ✓ National Development Plan 2018 -2027 (PND Burundi 2018 – 2027)
- ✓ National Agriculture Strategy (2008 - 2015)
- ✓ Agriculture National Investment Plan (2018 - 2022)
- ✓ National rice development strategy in Burundi, 2014

National Policy on Agriculture

a. Promote agriculture in the country

- ✓ Loi N° 1/ 23 du 23 Novembre 2017 portant protection des végétaux au Burundi
- ✓ Loi N° 1/08 du 11 Mai 2008 portant gestion des pesticides au Burundi

- ✓ Loi N° 1/05 du 12 Mars 2010 portant réglementation de la production et de la réglementation de la production et de la commercialisation des fertilisants et des amendements des sols au Burundi
- ✓ Loi N° 1/ 08 du 23 Juillet 2012 portant organisation du secteur semencier au Burundi
- ✓ Loi N°1/02 du 26 Mars 2012 portant code de l'Eau au Burundi
- ✓ Loi N° 1/010 du 30 Juin 2000 portant code de l'Environnement de la République du Burundi
- ✓ Politique Nationale de l'Eau, Septembre 2009

b. That may hinder /encourage agriculture

- ✓ Loi N° 1/23 du 30 Décembre 2011 portant cadre organique des groupements pré cooperatives agricoles
- ✓ Loi N° 1 / 21 du 4 Octobre 2018 portant stabulation permanente et l'interdiction de la divagation des animaux domestiques au Burundi
- ✓ Decret 100/ 177 du 9 Juillet 2013 portant mesures d'inspection sanitaires des animaux et des produits alimentaires d'origine d'origine animale
- ✓ Loi N° 1/ 28 du 24/12/ 2009 relative à la police sanitaire des animaux domestiques sauvages; aquacole et abeilles
- ✓ Loi N° 1/ 06 du 21 Mars 2011 portant réglementation de l'exercice de la profession vétérinaire
- ✓ Ordonnance Ministérielle N° 710/241 du 26/04/1999 mettant en place le comité national chargé de l'homologation et de contrôle des pesticides
- ✓ Ordonnance Ministérielle N° 710/ 406 du 24 / 03/ 2003 portant code national de conduite de gestion des pesticides
- ✓ Ordonnance Ministérielle N° 710/837 du 29/10/2001 portant registre des pesticides à usage agricole homologuée au Burundi
- ✓ Ordonnance Ministérielle N° 710 / 838 du 29 /10/2001 portant registre des pesticides à usage agricole interdit au Burundi
- ✓ Politique nationale sur les changements climatiques au Burundi, Novembre 2013
- ✓ Décret n°100/22 du 07 octobre 2010 portant mesures d'application du code de l'environnement en rapport avec la procédure d'étude d'impact environnemental.

c. EAC Directives framework.

- ✓ Manual of procedures for the submission and evaluation of technical data including efficacy and residue testing of pesticides
- ✓ Administrative requirements and guidance document for the conduct of efficacy trials for pesticides;
- ✓ Directives and regulations for the protection of confidential commercial information;
- ✓ Harmonization of phytosanitary legislation of Partner States of the EAC;
- ✓ EAC and COMESA sanitary and phytosanitary measures;
- ✓ Harmonized lists of quarantine pests of the East African Community

2.3 Rice Production systems and value chain in Burundi.

Rice is grown throughout the country except in the Mugamba region (high altitude region). According to the National Strategy for the Development of the Rice Sector, there are three types

of rice cultivation in Burundi, namely: Irrigated rice cultivation in the plains and high marshes, flooded rice cultivation in unmanaged marshes and rain-fed rice cultivation on the hills.

According to the 2016 Yearbook of Agricultural Statistics, 70,911 tons of rice were produced in 2007, while in 2016, 146,633 tons of rice were produced (Table 2.1). Rice production increased during the five years, 2007 to 2011, followed by a disturbance of rice production from 2012 to 2012 and a spectacular increase in 2016. However, a significant amount of rice imported from abroad**.** Burundians import rice mainly from Tanzania and Zambia. The Bulletin of Foreign Trade (3rd quarter 2018) of the Institute of Statistics and Economic Studies of Burundi (ISTEEBU) reports that 3,219.1 tons of rice were imported in the third quarter of 2018. This quantity has a value of 3,768 .7 million BIF.

Table 2. 1 Rice production over ten years (2007-2016)

Crop/year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Rice production in tons	70911	74492	78432	83019	91415	64629	41456	67377	38674	146633

Source: Yearbook of statistics 2016

Rice falls in category 2 and priority 4 in the crops grown in Burundi after beans, which has the highest category (rated 5 as the highest at 0 as the lowest) and is intended for intensification. Tables 2.2 and 2.3 show the key rice production areas and farming systems and their geographical distribution in Burundi. In Burundi, most of the crop is grown in lowlands, although it is also found in highland areas. Critical rice production systems in the country are rain-fed and supplementary irrigation.

Table 2. 2 Key rice production areas and farming systems and geographical distribution

Geographical area	Administrative Location	The area under crop (Ha)	Farming method	Growing season	Gender role in farming	Yield/acre	By-products	Major markets	Price/kg
Lowland	Imbo plain	27265	Transplanting	Two seasons	Female are the majority	60 kg/acre	50 Kg/acre	Town : Buja, Gitega, Ngozi	Around 1 Usd/kg of milling rice and 0,75 Usd/kg of paddy rice
Lowland	Moso plain	Still checking	Transplanting	Two seasons	Females are the majority	60 kg/acre	50 Kg/acre	Towns: Buja, Gitega, Ngozi	Around 1Usd/kg of milling rice and 0,75 Usd/kg of paddy rice
Lowland	Moso plain	Still checking	Broadcasting	One season	Females are the majority	30kg/acre	10 kg/acre	Towns: Buja, Gitega, Ngozi	Around 1Usd /kg of milling rice and 0,75 Usd /kg of paddy rice
High altitude		2814	Transplanting	Two seasons	Females are the majority	40kg/acre	30 kg/acre	Towns: Gitega, Ngozi	Around 1 Usd/kg of milling rice and O,75 Usd /kg of paddy rice

Table 2. 3 Critical rice production systems in Burundi

Rice growing Location	Land/seedbed preparation			Planting and weeding		Harvesting process		Cost of production /acre (local currency)
Name	Rain-fed	Supplementary irrigated	Fully irrigated	Seedling/ transplant	Seed broadcast	Manual labour	Mechanical	
Imbo plain			X	X		X		**20,5 Usd**
Moso plain			X	X		X		**20,5 Usd**
Moso plain	X				X	X		**15 Usd**
High altitude			X	X		X		**20,5 Usd**

Rice, as a crop, has basic requirements such as seed, fertilizers, and water for irrigation, depending on the production system. Table 2.4 below shows the primary inputs under different production systems. Other inputs include pesticides, equipment, and labour, among others.

Table 2. 4 Requirements and inputs for rice production (listed in order of priority)

Rice growing location	Irrigation system			Production method Pure		Crop planting method		
Name	Rain-fed	Supplementary irrigated	Fully irrigated	intercrop	Pure crop	Seedling/ Transplant	Seedbroadcast	Line planting
Seed	X		X		X	X	X	X
Fertilisers	X	X	X	X	X	X	X	X
Irrigation		X	X	X	X	X	X	X

2.4 National Policy that promotes and factors that hinder rice production

2.4.1 The National Rice Development Strategy in Burundi (SNDR-B)

Its overall goal is to produce rice, in a competitive, profitable and sustainable manner, with superior quality to imported rice, which meets the current national needs as and responds to the likely increase in demand after a rise in population, the rural exodus and the evolution of consumption habits, and to generate surpluses for export. This strategy covers all methods of rice production, namely irrigated lowland rice, irrigated marsh rice, and rainfed rice. It supports

processes involving modern agriculture (i.e., more capitalized and mechanized) more than those oriented towards self-subsistence. The strategy has the desire to make rice production a profitable activity for the different categories of farmers, capable of productively contributing to ensuring food security and fighting poverty in Burundi. The implementation for the rehabilitation and development projects on approximately 16,000 hectares of lowland rice fields and 9,000 hectares of marshland rice fields is in the PNIA. It should make it possible to cover national needs in rice by 2020 with a planned production of 169,000 tons of milled rice (compared to 56,000 tons in 2011 and 135,000 tons in 2015) for an estimated consumption in 2020 of between 117,000 and 159,000 tons of milled rice.

The rice areas in different provinces were surveyed to obtain figures at the supply level, distinguishing between the developed and unmanaged regions for the three production methods (plain, marsh, rainfed) in 2011 and 2015 with a status quo in 2020, a period for which no programming has yet been envisaged. The expected average yields for rice growing in plains and developed marshes were set at 3.5 tons of paddy/ha for 75 to 80% of the area and a single annual production cycle in 2012. For 2015 and 2020, the yield would increase to 4 tons/ha for 95% of the area. In 2020, two annual paddy crops are planned for 30% of the total area.
These production levels, based on particularly cautious yields and largely exceeded by farms already using an intensive system, could be further consolidated by the implementation of the various actions contained in the other axes of the proposed Strategy.

2.4.2 Priorities of National Strategy for rice development in Burundi

The priorities of the (SNDR-B) will be organized around five complementary and distinct axes:

Organization structure- The organization of rice farmers in production areas is through operational cooperatives in specialized regions of irrigated plains (sectoral for the plains of Imbo and Mosso and multifunctional in marsh areas). Before the work is carried out, awareness-raising and empowerment actions for water users must be carried out. It is also essential to initiate without delay actions for the structuring of rice farmers who go through the organization of producers, the strengthening of training and information for members, the improvement of the management capacity of leaders in ensuring compliance with statutory rules and internal regulation
Fit- The rehabilitation of sites developed for rice cultivation and the creation of new developments for the plains (16,000 ha) and marshes (9,000 ha), which represent potentially large areas for more intensive and mechanized rice cultivation. A hypothesis of 2 years of delay was taken into account to remain realistic.
Intensify- intensification of rice production by providing inputs, in particular, selected rice seeds in all production areas, fertilizers by adopting the system newly approved by the government and phytosanitary products within a framework environmentally and health safe. Actions at the production level are directed towards the adoption of more intensive farming techniques and, in particular Intensive rice system (IRS), with the use of these inputs and support for mechanization at all stages, including post-harvest activities.
Transform- Support for the processing and marketing of local rice through actions to promote the emergence of the private sector and the establishment of partnership contracts between the various stakeholders in the sector (seed producers, associations of producers, processors,

traders). It should also encourage secondary processing to diversify the final products (parboiled rice, starch, or rice flour, among others.) and develop by-products (heating bricks, plywood, etc.).

Federate- The establishment of a coherent and operational institutional framework at the level of support for the production, processing, and marketing of rice, which takes into account the necessary restructuring of the SRDI, the creation of professional families for ultimately lead to an Inter-professional Organization.

2.5 Important political challenges in Burundi

Given the importance of rice in food security and even food sovereignty, the Strategy identifies the following political challenges:

- ✓ Satisfying the needs for 100% of national rice consumption by 2020 at the latest;
- ✓ Guarantee of a stable and profitable income for the rice farmer;
- ✓ Reduction in rice imports and large foreign exchange outflows;
- ✓ Promotion of rice produced in the national territory to consumers;
- ✓ The supply of milled rice from the sub-region, taking into account the strengths and potential of Burundi.

2.6 The Strategic plans to cover national rice needs

By 2020, the strategy will aim to increase local production to reach 169,000 tons of milled rice for consumption. From 2015 the production level has been 135,000 tons of milled rice for an estimated consumption of between 103,000 and 140,000 tons of milled rice for the same period according to the assumption (minimum or maximum) adopted in terms of demand. As mentioned in Table 2.5 below:

Table 2. 5 Evolution of supply and demand for milled rice following the Maximum assumption

Years	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Rice Offer	56 060	69 851	87 034	108 445	134 930	141 137	147 629	154 420	161 523	169 337
Minimum Requirement	93 410	95 745	98 139	100 592	103 137	105 818	108 569	111 392	114 288	117 363
Balance	-37 350	-25 894	-11105	7 852	31 793	35 319	39 060	43 028	47 235	51 974

Source: National rice development strategy in Burundi

The expected impact of the implementation of this National Rice Development Strategy for Burundi (SNDR-B) is to enable Burundi to cover its consumption needs with its national production and thus contribute to the development of the economy, the maintenance of social peace and the creation of new jobs. This will make a useful contribution to the fight against poverty and food insecurity in the country and the sub-region.

The impact indicators are:

- ✓ Covering consumption needs by local food production by 2020 at the latest with the output of around 169,000 tons of milled rice;
- ✓ inversion of the trade balance with foreign exchange earnings of at least $ 5 million;
- ✓ The creation of at least 50,000 direct jobs, for paddy production under water control, processing, and services;
- ✓ Increased income and self-financing capacity of rice farmers;
- ✓ Improvement of living standards and social amenities in rice-growing areas.

Following the analysis of the problems, it appeared necessary to target the intervention over the next ten years with the first phase of 2012-2017 corresponding to the PNIA period and a second phase 2018-2022, around five main axes strategic.

Other national policies promoting rice production are in Burundi are:

- ✓ National Agric & food security: fertilizers subside, seeds subside
- ✓ Water and land use: Ministry of Environment, Agriculture, and Livestock (MINEAGRIE)
- ✓ Gender and agric/food production/marketing: females are the majority
- ✓ Heath, age issues: Young people are involved in rice production
- ✓ Water and environmental conservation Ministry of Environment, Agriculture, and Livestock (MINEAGRIE)
- ✓ Land ownership and gender issues: each rice farmer owns a small farm

Factors that may hinder/encourage rice production

- ✓ Gender and agric/food production/marketing
- ✓ Land ownership and gender issues
- ✓ Socio-economic and property rights
- ✓ Taboos and traditions linked to Burundian culture

National institutional arrangements on Agriculture and rice production and their role in Promoting rice production in the country

- ✓ Ministry of Environment, Agriculture, and Livestock
- ✓ Governmental departments dealing with rice production, water management and marketing in the country
- ✓ Directorate responsible for IWRM
- ✓ Provincial Offices in Charge of Environment, Agriculture and Livestock (**BUPEAE)**
- ✓ Burundian Agronomic Scientific Institute (**ISABU)** for research;
- ✓ National Office for seed control and certification (**ONCCS),** seed selection**,**
- ✓ International Rice Research Institute (IRRI)

Stakeholders in the rice production chain

- ✓ Regional Society for Imbo Development (country-western) in charge of rice **(SRDI),**
- ✓ Cooperatives
- ✓ Seeds growers
- ✓ Privates' farmers
- ✓ Small associations
- ✓ Traders

Options for intensification, scaling rice production in Burundi

Rice development opportunities in Burundi are:

- ✓ A significant potential of land suitable for rice development
- ✓ Relatively abundant quality water resource and rainfall suitable for rice cultivation,
- ✓ The existence of varieties of rice with high yield and good organoleptic quality that are not fully exploited
- ✓ The existence of varieties of marshes with high yields but whose quality remains to be improved;
- ✓ The existence of a partnership with the international research institution (IRRI) that can provide access to new, more efficient varieties;
- ✓ A new Land Code adopted in 2011;
- ✓ The existence of the Agriculture National Investment Plan (PNIA in French) and the commitment to rehabilitate and develop irrigated areas;
- ✓ The profitability of rice production and remunerative prices;
- ✓ The existence of a strong national and sub-regional demand maintained by the rural exodus
- ✓ Some achievements of SRDI (Regional Society for Imbo Development (Sub –Western Regional) in terms of structuring and support for rice farmers

2.7 Selected pilot: Nyavyamo Marsh in Kirundo Province

2.7.1 The geographic location and population of the Province of Kirundo

Located in the north of Burundi, Kirundo province borders the North and West with the Republic of Rwanda, in the South and East with the province of Muyinga. Its area of 1,073.34 km^2 represents 6.1% of the national territory. It is in the 8th position in terms of national scope. It comprises of 7 municipalities mainly located in the Bugesera region (88%) and the rest in the natural area of Bweru (12%).

Administratively Nyavyamo marsh is located between the municipalities of Kirundo and Ntega in the province of Kirundo. It is situated between the hills of Bugera, Mutwenzi, Karehe, Nyange, Rambo and Gikuyo in the town of Kirundo and the hills of Murungurira, Gitwenzi, Susa, Rwimbogo and Nyakibingo in the town of Ntega and extends into the town of Bugabira through the branches of Rwihinda Lake. It is in the natural region of Bugesera, in the northern part of the Republic of Burundi, on the border with Rwanda. It is part of the AKanyaru basin and drains several sub-basins for which it constitutes the point of convergence of the waters. With an area of 1,420 ha, the Nyavyamo marsh includes a marshy area bordering Lake Rwihinda, which carries papyrus vegetation and significant biodiversity, has been delimited and reserved as an organic buffer zone for papyrus in the lake and the area to be developed, in the valley of the upstream arms of the marsh, delimited downstream from the upper basin where the runoff water which feeds the rivers is collected.

Nyavyamo is an organic marsh, which is exceptional to other bogs in the Bugesera area in Kirundo province, where most marshes are peat the part to be developed covers an area of 1332.5 ha, which is subdivided into three blocks A, B, and C. The first block (A) includes the tributary arms of the marsh, the second block (B) is located in the middle part of the swamp, and the third block (C) is in the downstream portion of the marsh. The area already developed covers 538 ha, and 300 ha is planned for development. Two irrigation outlets from the swamp supply the blocks with water and cut the marsh into sections. Rice producers in the Nyavyamo marsh

are organized into ten cooperatives in the irrigation sectors. The demographics provided by the provincial administration are presented in Table 2.6. The demographic data shows that the population of Kirundo province is higher than the national average. It is, therefore, expected that the average exploitable area would be lower than the national average, which is estimated at 50 acres. This implies sustained and fairly significant efforts to ensure food security for the population of the province.

2.7.2 Geographic Map

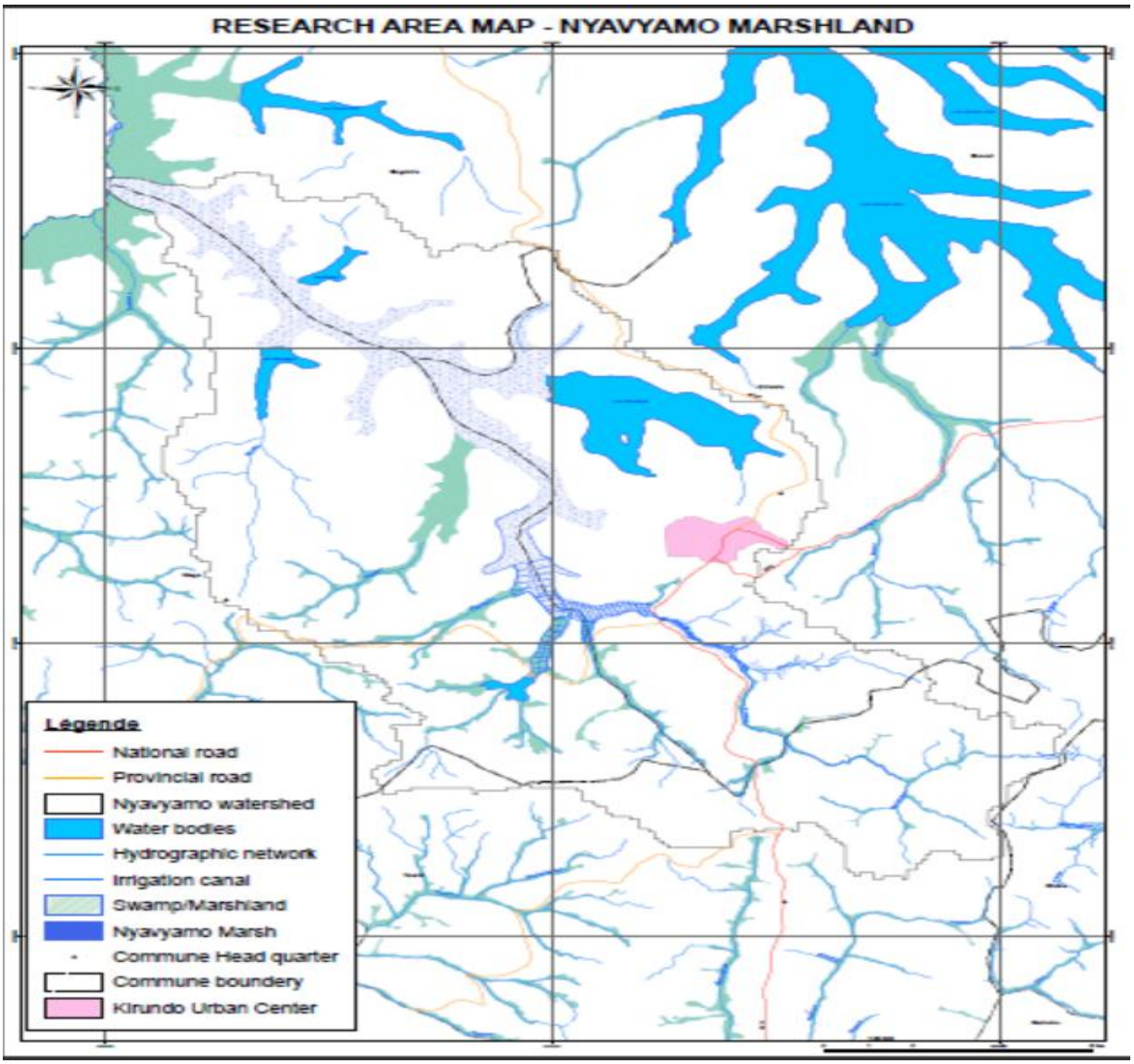

Table 2. 6 Kirundo provincial demography

N°	Communes	Area (Km2)	Population	Density
1	Bugabira	135.32	111 672	474

2	Busoni	420.89	203 430	483
3	Bwambarangwe	193	93 806	486
4	Gitobe	180.20	85534	475
5	Kirundo	207.29	120892	584
6	Ntega	261	145896	559
7	Vumbi	206	99803	486
8	**Total**	**1703.34**	**861033**	**507**

Source: Provincial Report, 2019

2.7.3 Climate and hydrology

A climate tempered mainly by the altitude in the south, a tropical rainy type climate with a moderately long dry season. The occurrence of disasters is higher in the natural region of Bweru in the south and medium to low in the natural area of Bugesera, which has experienced continuous droughts in recent years. The temperature varies slightly between seasons and is between 20-21 ° C in the Bugesera and 16 to 19 ° C in the natural region of Bweru. Climatic variations and in particular drought in recent years, combined with a population density, have led to the exploitation of the marshlands previously flooded and occupied by papyrus and which constitute significant water reserves to offset the effects drought. The dense hydrography, average to good rainfall, and high retention of water resources in lakes and the marshes mitigate the impact of drought. The province falls entirely within the greater Nile basin.

2.7.4 Vegetation and fauna.

The vegetation in Kirundo province is vibrant and varied, particularly in protected areas and around Rweru and Cohoha lakes. In protected areas, we find vegetation dominated by *Acacia gerrandi*, *Acacia polyacantha*, *Bredelia atroviridis*, *Acacia meansis*, *Albizia sp*, *Ficus sp*, *Eucalyptus grandis*, *Eucalyptus saligna*, *Eucalyptus maidenii*, *Grevillea sp*, *Cedrella sp*, *Markhamia sp*, *Callitris sp*, and *Euphorbia turcalli* among others. In the swamps of Lakes Rweru and Cohoha, there are papyrus and phragmites. The fauna is also very varied, primarily in the protected areas. There are approximately 59 species of mammals distributed in 18 families, including Bovidae and Viverridae. The large predators are few, namely *Pantera pardu*, *Comis adustus*, and *Pantera leo*.

2.7.5 Economic activities

The economy of Kirundo province is agriculture-based, with more than 95% of the population engaging in this sector conditions the primary income of the people. It is the primary activity, and all the factors of development are conditioned by the availability or lack of agricultural production to the point that the degree of poverty of the population varies according to the periods of the farming season.

2.7.6 Agriculture and livestock

The agriculture practised in Kirundo province is a mixture of subsistence, industrial, and market gardening. Food crops are grown on the hills, and in the marshes, however, rice cultivation is becoming increasingly important. This agriculture is mainly intended for self-consumption but

also marketing. The primary food crops within the Kirundo area are presented in Table 2.7. Rice cultivation is done in developed and undeveloped marshes; the developed marshes occupy around 1000 ha, and the rice is cultivated in 2 seasons annually. Sweet potatoes are grown in unimproved swamps after the rice harvest. Industrial agriculture is almost exclusively represented by the coffee, which is the dominant cash crop in the province. The other crops grown are sunflower, oil palm, and peanuts. Market agriculture is characterized by low production in quantity and quality and is practised on small plots, the output of which is mostly for self-consumption. Fruit crops also exist on farms. For almost ten years ago, agricultural production has been seriously jeopardized by climatic variations to the extent that famine has been observed more frequently in the province formerly considered to be the breadbasket of the country due to the importance of its exports of food products to other countries, other regions of the country.

Table 2. 7 Main sources of food crops grown in the area.

N°	Food cultivation	Estimated Production in %
1	Beans	80%
2	Maize	80 %
3	Bananas	60%
4	Rice	40%
5	Sweet potatoes	30%
6	Sorghum	20%

Source: Kirundo provincial investment Plan 2013 – 2017

2.7.7 Fishing and fish farming

Fishing takes place in the province's seven out of eight lakes. These are the Cohoha, Rweru, Rwihinda lakes commonly known as the protected "Bird Lake," Gacamirindi, Kanzigiri, Mwungere, Narungazi, and Gitamo found in the municipalities of Kirundo, Bufgabira, Busoni, Bwamabarngwe and Ntega. This fishing is exclusively traditional with relatively low production and artisanal tools. Fish farming, on the other hand, is practised in a hundred ponds spread over all the municipalities with an average area varying from 2.6 to 6 acres. The average production is very low and varies between 850 kg/ha and 4000 kg/ha in Busoni and Kirundo, respectively.

2.7.8 Operating system and crop calendar

The farming system in the Nyavyamo Marsh is extensive. The farms are classified into four according to the age of the farm managers, the average size of people per farm, the area farmed, and the possession of livestock for organic manure for the increase of rice production.

- ✓ Small farms are characterized by relatively young farm managers, with an average of age 39, having a group of 4 people who farm an average area of 0.2 ha with a goat per farm
- ✓ Medium-sized farms are characterized by farm managers aged on average 44 years old, grouped into five people who farm an average area of 0.5 ha with an average of two goats per farm;

- ✓ Intermediate farms are characterized by farm managers aged on average 48 years old, grouped into seven people who farm an average area of 1.1 ha with an average of one cow and three goats per farm;
- ✓ Large farms are characterized by farm managers aged on average 50 years, grouped into eight people who farm an average area of 2 ha with two cattle and four goats per farm.

In the Nyavyamo marsh, rice is grown in two seasons a year. The first rice-growing season (season B) is from January to June, and the second season (season C) runs from July to December. The factors that determine the number of seasons in which rice is grown are the level of development of marshes, the availability of fertilizers and inputs.

2.7.9 Field operations for rice production.

The land preparation operations are done manually, including ploughing and cleaning, weeding, application of inputs, cutting, piling, and threshing. Rice planting activities start with nursery preparation and then transplanting in lines. The costs of operations ranging from land preparation to rice harvesting are shown in Table 2.8 below.

Table 2. 8 Rice cost production process

N °	*Production process*	*Cost (Local currency)*	*USD*
1	Land preparation	83300	42,5
2	Planting	Variable	Variable according season
3	Weeding by acre	27700	14
4	Cut by acre	55500	28
5	Crowding by acre	13500	7
6	Threshing by are	40500	21

2.7.10 Varieties and origin of seeds and rice yields.

The varieties most preferred by growers are CTA 087, FACAGRO 964, V 564, V 1380, YUNY, Rice (Buzosi), Rice (MUSOMATI), Rice (Buguru bw'inkware). The area devoted to these varieties remains average, the proportions depend on the preferences of farming communities. Many farmers who cultivate rice in the Nyavyamo marsh obtain seeds from the market or harvest their crops. With the development of the Nyavyamo marsh, the yield per ha has improved compared to the production of the pre-development. The average yield is estimated at 5 tons per ha. After harvest, paddy rice is sold in 50 kg bags.

2.7.11 Activities in the rice value chain

At the organizational level, producer groups have been set up for the proper management of the marsh and all gender groups are involved: adult men and women, young women and children, boys and girls. They all participate in rice production operations as in Table 2.9 below. The agricultural inputs used in rice production are mainly organic fertilizers, chemical fertilizers like urea and KCl, and pesticides. Access to these chemical fertilizers and pesticides is possible,

courtesy of the government's program through the Ministry of the Environment, Agriculture and Livestock providing agricultural inputs. Income from the sale of rice is used both to meet the daily needs of households and also to buy seeds.

Table 2. 9 Gender groups and their involvement in the rice cultivation process.

N°	Process	Gender groups involved in activities				
		Adult Men	Adult Women	Young Women	Children boys	Children Girls
1	Land preparation by hand	X	X	X	X	X
2	Construction of dikes in case of new fields, repair of old levees and cleaning of inlet channels	X	X	X	X	
3	Seed acquisition and preparation	X	X	X	X	
4	Nursery preparations	X	X	X	X	
5	Hand raking	X	X	X	X	
6	Waste removal	X	X	X	X	
7	Transplantation	X	X	X	X	X
8	Weeding	X	X	X	X	
9	Pest control	X	X	X	X	
10	Bird scaring	X	X	X	X	X
11	Harvest / cut	X	X	X	X	
12	Pile and threshing	X	X	X	X	
13	Bagged	X	X	X	X	
14	Paddy transport from the field	X	X	X	X	X
15	Drying and winnowing after transport from the farm	X	X	X	X	X
16	Water Management	X	X	X	X	
17	Transport for shredding	X	X	X	X	

After harvesting rice, the by-products are used to feed livestock, or left in the fields to serve as organic manure after rotting. Farmers are, however, facing several difficulties in rice operations associated mainly with flooding, pests and conflicts related to water management. To mitigate these challenges, the farmers' clear irrigation canals, apply insecticides and resolve disputes through a swamp management committee set up by the farmers in collaboration with the service of the Provincial Directorate of Environment, Agriculture and Livestock (BPEAE) of Kirundo province. According to the Director of Environmental, Agriculture and Livestock supervision and the various stakeholders involved, the farmers in the Nyavyamo marsh are organized into producer associations in the form of cooperatives. A total of 10 cooperatives, including one for disabled people, have been set up in the production areas.

The plots of disabled people who cannot carry out rice growing operations are often rented and subject to the usufruct. A Kabamba fish-farming lake located in the Gatwe, Nkogwe and

Rushubije hills in the Nyavyamo marsh has been established for irrigation and promotion of fish farming and consequently another fishermen's cooperative established for the management of the lake. In addition to rice, other crops grown after the rice harvest are corn, sweet potatoes, onions, and cabbage. The produce grown around the rice fields are mainly cabbage, tomatoes, and eggplant. Vulnerable groups benefit from the rice farms, either by cropping them through paying with labour, usufruct or by sharing of yields with the farmers. The farmers' groups have a constitutional framework in which the rice producers are organized to benefit from the support of partners to improve their technology, increase agricultural production and monetary income. To this end, the equitable distribution of plots and inputs has thus promoted tenure security for farmers; hence sustainable farming can be achieved. In the event of conflicts, there are rules which govern the block. Other regulations involve respecting the schedule, maintaining the structures, and honouring the payment of royalties. But some members do not respect these rules, provincial agriculture head officers with local authorities are in charge of those issues.

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3 KENYA

3.1 The prevailing status and plans for rice production in LVB-Kenya

Rice cultivation in Kenya started in 1907and was introduced from Asia. Rice, currently the third most important cereal crop after maize and wheat is mainly grown by small-scale farmers as a food crop and for sale. Nearly 80% of the rice grown in Kenya is under irrigation in schemes established by the Government, while 20% is produced under rain-fed conditions. Table 3.1 shows the production of rice in significant irrigation schemes in Kenya.

Table 3.1 Production of rice in significant irrigation schemes in Kenya.

Scheme	Production(tons)		
	2013	2014	2015
Mwea	64, 672	70, 416	91, 624
Ahero	8, 326	7, 405	7, 942
West Kano	5, 165	4, 345	4,660
Bunyala	4, 278	4, 289	4,600
South West Kano	8, 262	9, 574	10, 268
Total	90, 703	96, 029	119, 094

Source: Kenya Bureau of Statistics (2016)

Whereas the majority of the urban dwellers consume large quantities of rice, most Kenyans living in the rural areas consume limited quantities. Rice consumption in Kenya is expected to maintain an upward trend, driven mainly by increasing household incomes, and urbanization and despite maize being the leading staple food, rice consumption is growing at a rate of 12% compared to 4% for wheat and 1% maize. Kenya had a production of about 119,000 metric tons annually from 2010 to 2014 (FAOSTAT, 2014), which meets only about 20% of consumption, and imports by private traders offset the resultant deficit. Asian countries continue to dominate rice exports to Kenya. In 2017/2018, key rice exporting countries to Kenya were Pakistan, Thailand, China, India, and South Korea. Kenya exports modest amounts of rice to neighbouring countries (Uganda and South Sudan). Table 3.2 shows the national production, area harvested and yields of rice from 2000 - 2018. There is still enormous potential for rice production in the country, and promotion of this will, therefore, improve food security, raise smallholder farmers' earnings, contribute to the creation of employment in rural areas, and decrease the rice import bill (NIB, 2015).

Table 3.2 The national production, area harvested and yields of rice from 2000 -2018

Year	production in tonnes	Area harvested /ha	Tonnes /ha
2000	52349	13882	3.771
2001	45000	13200	3.4091
2002	45000	13000	3.4615
2003	40502	10781	3.7568
2004	49295	13223	3.728
2005	62677	15940	3.9321
2006	64840	23106	2.8062
2007	47256	16457	2.8715

Year	production in tonnes	Area harvested /ha	Tonnes /ha
2008	21881	16734	1.3076
2009	42202	21829	1.9333
2010	85536	20181	4.2384
2011	111229	28034	3.9676
2012	138204	29630	4.6643
2013	125256	31349	3.9955
2014	112263	28390	3.9543
2015	116473	29438	3.9566
2016	101510	29337	3.4601
2017	101866	27829	3.6605
2018	110325	25966	4.2489

3.2 Status of rice in National Policies

Various government reforms and plans have involved and affected the Ministry of Agriculture and the Agriculture Sector over the years. Reforms such as PRSP, ERS, ASDS and Vision 2030 are mainly geared to ensuring food security, food self-reliance and poverty reduction among the people of Kenya. Subsequently, the Ministry developed a strategic plan (2006–2010) which committing it to improved service delivery and interventions. With the awareness of Vision 2030, ASDS, the draft National Food and Nutrition Security Policy (NFNS) and the Ministry's Strategic Plan 2008 – 2012, the National Rice Development Strategic Plan was developed to chart the course of rice production and development for the next twenty (20) years in five-year phases. The National Rice Development Strategic Plan will guide the Ministry and its development partners in improving the livelihoods of rice farmers and consumers in terms of food and income by providing technologies.

3.3 Policies in Kenya related to rice development

3.3.1 Strategy to Revitalize Agriculture (SRA) 2004-2014)

The policy paper actualizing the SRA was based on a broad objective of embracing a broad-based growth and development of agriculture and by extension development of rural Kenya through activities aimed at improving agricultural and livestock production and real farm incomes, availability and access to food. The main deliverable was transforming subsistence farming to commercial production. Formulation of this sectoral strategy was triggered by the national policy of Economic Strategy for Wealth and Employment Creation (ERS). The policy orientation was to contribute to the achievement of Vision 2030.

3.3.2 The Agriculture Sector Development Strategy (ASDS) 2009-2020

Formulated to take over from the SRA and align the sector initiatives to Vision 2030 with due recognition of the achievement of the SRA. The policy expressed in the context of global commitment and national policies and comprehensively took up the primary goal of Comprehensive Africa Agriculture Development Programme (CAADP) of eliminating hunger, reducing poverty and food insecurity beside opening the way for export expansion. During the

period of the SRA implementation, the agricultural sector recovered from a growth rate of negative 3% in 2002 to a positive 5.4% in 2006.

Growth of the agriculture sector influences the growth of the economy because it generates industrial raw materials, export earnings and employment hence, it deserves attention in terms of investments that can support improved productivity and sustainable growth. Such investments include the development of irrigation structures, research, water harvesting and storage facilities that would increase productivity and the growth of the sector and the economy. Agriculture faces challenges related to productivity, land use management, linkage to markets and lack of value addition to farm produce that need to be addressed through a holistic approach that considers investments in irrigation development, capacity building of the stakeholders, organizational development of stakeholder entities, market development and product diversification, among others.

3.3.3 Water Management and Agricultural Policy

Past irrigation development strategies and approaches are contained in several policy papers on agriculture, food security and water development including the Sessional Paper No.4 of 1981 on National Food Policy, Sessional Paper No. 1 on Economic Management for Renewed Growth, Sessional Paper No.2 of 1994 on National Food Policy, the Economic Recovery Strategy (ERS) (2003 - 2007), Strategy for Revitalizing Agriculture (SRA) 2004-2014, the Water Act (2002) and Vision 2030. Irrigation and drainage are identified in all these documents as key to the intensification of agriculture through increasing production and productivity of the land. Although opportunities existed for the implementation of the envisaged policy changes, little has been done in terms of initiatives to actualize the strategies as laid out.

The 1966 Irrigation Act (CAP 347) and other separate pieces of legislation that created the NIB allowed for the uncoordinated development in the irrigation sector for a long time. This led to a lack of proper enterprise selection prioritization, production standards, organization of producers and focus on external factors including environmental conservation aspects.

3.3.4 The Irrigation Policy

The policy's the key objectives include expansion of land under irrigation and drainage through increasing available water capacity from the present 5.3m³ to 60m³ per capita, mobilize resources for investments in the irrigation subsector, seeking partnerships with the private sector, creation of an enabling environment for stakeholder participation, Promotion of multi-sectoral approach for enhanced innovations, research and technology adoption and capacity building and development of the stakeholders. With the new policy guidelines, the government will not need to be involved intensively in the production activities but only facilitation of the activities This will relief NIB of the burden of having to regulate, enforce and operate the rice and seed maize growing schemes.

3.3.5 Kenya National Rice Development Strategy (NRDS) 2008-2018

NRDS was developed in 2008 and headed by the MOA in collaboration with stakeholders in the sector and development partners. Its overall goal was to improve food security and income of

Kenyans through sustainable rice production, marketing and utilization. The vision was to have a vibrant sector that contributes to improved livelihoods, food security and economic growth. NRDS aimed to achieve its objectives through increased rice production, productivity, value addition and competitiveness supported through the existing Government policy documents on food security, such as SRA, NFNSP, ASDSP, Vision 2030 and the Kenya constitution.

In line with the existing government policies on food self-sufficiency, the NRDS is addressing technical issues, training of researchers, the extension on the modernization of rice production techniques and utilization. It is also working to revitalize existing training institutions to conduct rice specific courses while also ensuring that qualified extension officers are posted in rice-growing areas while avoiding high turnover of staff. It is also strengthening rice quality inspection and enforcement mechanisms. Besides, NRDS is expected to enhance the accessibility of affordable farm inputs and equipment and ensure that appropriate farm tools and equipment are developed to reduce drudgery. Further, the Government, through the NRDS, will play a key role in rice variety development, maintenance and seed production in partnerships with key stakeholders. It will also support access to credit support through CIGs and cooperatives while developing the necessary infrastructure especially roads and transport facilities in rice-growing areas; construct and maintain major irrigation infrastructures; improve and strengthen health services to control water and vector-borne diseases in rice-growing areas.

Steps will be taken to enhance the collection of water tariffs and cess and ensure proper management by ploughing back to rice-growing areas with farmers' represented in all committees. The NRDS will ensure that environmental impact assessment and audit are conducted in cases where some large scale rice investments are envisaged, improving marketing structure, and increased PPP in rice marketing which includes buying rice for its strategic food reserves. Through a presidential decree on rice in 2020, farmers stand to benefit from the release of funds to the Kenya National Trading Corporation (KNTC) to purchase farmers' rice countrywide that will encourage a warehouse receipt system for rice farmers while creating fair competition from imported rice by enforcing rice standards through KEBS. Besides, NRDS advocates for the establishment of ICT market/price-oriented technologies for speedy and timely market information and also identify and exploit value addition

3.3.6 National Climate Change Response Strategy (NCCRS), 2010

The aim of the National Climate Change Response Strategy (NCCRS) is to respond to the challenges and opportunities posed by climate change. The objective of NCCRS is to strengthen nationwide focused actions towards adapting and mitigating against a changing climate, by ensuring commitment and engagement of the whole nation in combating the impacts of climate change, taking into account the vulnerable nature of the natural and ecological resources, and society as a whole. Environmental protection has been put in place as one of the critical national priorities in the context of Kenya Vision 2030 (the country's development blueprint covering the period 2008–2030) and under its National Climate Change Action Plan (2013–2017) to address the threats of climate change in Kenya.

3.3.7 The Irrigation Act

The Irrigation Act is intended to support sustainable food production by among other interventions establishing the National Irrigation Development Authority. It also outlines the roles of national and county governments in facilitating irrigation activities in the country.

Other policies include Agricultural Sector Transformation and Growth Strategy (ASTGS), Economic Recovery Strategy (ERS), National Agricultural Research System Policy (NARS) and National Food and Nutrition Security Policy (NFNSP) among others.

3.4 Policies and Institutional Challenges and Opportunities

Kenya government is committed to increasing food production as stipulated in its current policies and is already encouraging public-private-participation (PPP) and investment in agricultural production, including rice. Therefore, rice farming in the LVB is expected to benefit in this endeavour. Previously rice was hardly considered a strategic crop for food security, but the current government policy documents on food security, such as ASDS, NFNSP and vision 2030 are supporting its production both as a food and cash crop. Today rice consumption has outstripped production hence the need to focus on policies that enhance production to achieve self-sufficiency and import substitution opportunities.

The inconsistent legal and regulatory framework has affected the seed sub-sector which is governed by several Acts such as the Agricultural Act (Cap 318), Plant Protection Act (Cap 324), The Noxious W3.3.7. eeds Act (Cap 325), the Seeds and Plant Varieties Act (Cap326), the Pest Control Products Act (Cap 346, the State Corporations Act (Cap 446) and Specific commodity Acts which are enforced by different institutions and sometimes results in duplication of efforts and conflicts of mandates. Most of these Acts are outdated and inconsistent with reforms in the sector. The legal framework has not been revised to match the changes in the industry.

3.4.1 Rice farming, processing, and marketing in LVB

In Kenya's LVB rice is mainly produced by small-scale farmers in the Counties of Busia (Bunyala), and Kisumu (Ahero, West Kano), Migori (lower Kuja River basin and Kuria) and Homa Bay (Kimira-Oluch and Maugo). In these counties, many small-scale rice farmers provide labour and also earn their livelihood and income through rice production. Men, women and children are involved in rice production at various levels. Men are mainly engaged in land preparation (Ploughing, rotavation, and levelling, seedbed development and transportation while women and children mostly plant, weed, scare birds, harvest, thresh and dry the crop. Women dominate rice marketing though men are also engaged in local rice retailing.

In most of the LVB-Kenya, there is low adoption of rice growing technologies, a situation mainly associated with poverty, gender, relatively small farms, inadequate education and awareness, lack of resource and gender issues. Although women hardly attend seminars or training workshops, they remain central players in rice production a situation which may lead to adverse effects on adoption and upscaling of rice technologies. Therefore, intensified and increased rice production in LVB-Kenya will ensure food security, local incomes and save the loss of foreign exchange. Further, local rice production, processing and marketing will enhance livelihoods and revenue for both rural

and urban populations as well as create employment and provide better opportunities for small scale farmers and private investors.

3.4.2 Challenges/constraints in the rice sub-sector

Among the significant challenges experienced in the rice value chain are the unfavourable weather conditions, inadequate water for irrigation, acceptable variety, low and declining land productivity, high cost of inputs, poor infrastructure, lack of machinery, transboundary/regional issues, and human and institutional capacities with the rainfed rice system suffering the worst decline in performance. Among the identified challenges, the most critical one is the lack of development of high yield rice cultivars whose grain quality is not only acceptable to most consumers but also tolerant to local pests in both rainfed and irrigated ecosystems. Moreover, the poor post-harvest practices and recycling seeds for planting, contribute to the low-quality output. Rice farmers face high post-harvest losses which account for about15% to 50% of the market value of production.

Weak seed delivery systems as middlemen, in most cases, overprice or deliver sub-standard seeds or both, resulting in low-profit margins. The inability of farmers to access extension services is the result of the changes in institutions providing extension services to rice farmers. Before restructuring in early 2000, NIB now NIA used to offer extension services to rice farmers, especially in irrigation schemes. NIB withdrew from these services which were to be taken by MOA, but this has not occurred in some regions. The research was also moved from NIB to KALRO in early 2000. It has been observed that there are increased incidences of rice diseases attributable to the non-release of new varieties.

Land degradation and loss of soil nutrients either through soil erosion or continuous cultivation have significantly lowered rice production in most areas. Farmers are forced to spend many resources on fertility enhancement. Some farmers who cannot afford adequate fertilizers have, in most cases withdrawn from rice production or suffered severe losses. Destructive diseases such as rice rust, bacterial blight, sheath rot, rice blast and rice yellow mottle virus lower the quality and reduce the yields per unit area. Pests such as quelea birds, rodents such as rats, and rice gall midge cause substantial losses in the field. Most farmers also have limited knowledge of pesticide information, calibration and lack PPE.

In Kenya, there are several small private owned mills producing low and poor-quality rice which is a barrier to competitiveness. The small millers do not have proper milling equipment, poor handling and storage facilities, which lead to high levels of broken grains and increased foreign matter in milled rice. Consequently affecting the traders significantly and hindering access to quality paddy and milled rice in the market, thus a constraint to traders in expanding their activities. Furthermore, the sector lacks a coherent and comprehensive policy, plan, and program to tackle the many limitations and deficiencies in the rice sub-sector.
Therefore, policymakers, producers and millers need to identify, and promote high quality locally adapted rice varieties for branding in national, regional, and international markets to boost rice productivity. Strengthening research and development through training and adequate funding will also help to address some of the challenges above. The rainfed rice system needs to be given more serious attention in the process of revitalizing rice production.

The challenges plaguing rice sub-sector are summarised as follows:

- Pests such as quelea birds, rodents such as rats, and rice gall midge cause substantial losses in the field.
- Weeds lower the quality of the produce. They also make the farmers spend more money and time controlling weeds which in the long run reduces returns.
- Erratic rainfall in some of the potential areas for rain-fed production and inadequate water supply and poor water management affects the yields. At times of excessive downpours, the floods have often broken the temporary ridges and ravaged the fields with up to 100%. This is mainly as a result of poor water management.
- Inadequate infrastructure such as irrigation canals, roads, storage facilities and mills, among others
- Thin profit margins caused by high input prices and high cost of electricity for pumping water in most of the schemes have discouraged some farmers who have turned their plots into crops or lay fallow.

3.4.3 Opportunities in the rice industry

Despite the challenges Kenya faces in terms of rice productivity, there exist significant opportunities to increase rice production and strengthen both household and national food security systems. The government is trying to increase rice production through land expansion and rehabilitation of the existing schemes to reduce rice imports. Besides, the donor community has grown foreign aid assistance to Kenya to support programs that help reduce poverty and improve food security. Rice sub-sector has benefited dramatically through JICA and FAO to improve and develop underexploited rice-producing areas which will substantially increase production as well as improve on food security and farmers' incomes. Through research, low potential -pest susceptible old varieties should be replaced with new high yielding varieties with promising yield potential.

At the moment, the national research efforts through the Kenya Agricultural Research and Livestock Organization (KALRO) and its partners focus on rice research while the Ministry of Agriculture is providing extension. There is adequate capacity to conduct rice adaptability trials on rice breeding, agronomy, crop protection and socio-economics at the various KALRO stations and local universities. Nonetheless, capacity building is needed for researchers, extension staff and farmers in techniques for rice seed production, agronomy, post-harvest and processing.

Unlike other crops with well-organized seed production and certification by KEPHIS producing certified quality and high yielding rice seeds still pose a challenge to farmers in LVB, and the study finds that many farmers recycle seeds or obtain seeds or seedlings from other farmers. Currently, extension services are done through Common Interest Groups (CIGs) to establish their bargaining power for a better deal in the rice development value chain. There are established farmers' cooperative societies which need to be strengthened to complement the role of CIGs to ensure access to appropriate technology, credit, farm inputs and marketing of rice crop in a manner that eliminates the current exploitative tendencies by cartels.

Further, cultivation of hybrid rice should be encouraged by stakeholders through field sites demonstrations and making seed available to farmers. Currently, most farmers, processors and other end-users of agricultural mechanization technologies in Kenya do not use enough technologies for their farming and processing operations to have much impact on national productivity making the Kenyan rice value chain labour-intensive and uncompetitive. Most activities in the rice sub-sector are labour-intensive and conducted manually with low productivity

as a result. There exists an opportunity of promoting mechanization in the rice value chain depending on the desire of end-users across the country to adopt economically beneficial technologies, the willingness and capability of fabricators to produce low-cost equipment at affordable prices replicated from machines that have a proven record of technical and financial success.

Kenya has a potential of about 540,000 ha irrigable and 1.0 million ha rainfed for rice production, much of which is available in the LVB. With improved water harvesting, storage, underground water resource utilization and innovative management technologies, the current irrigation potential can be increased by a further 800,000 ha to 1.3 m ha. According to the Kenya Government strategy for rice production, there are plans to double rice production in the next ten years with an emphasis on irrigated and rain-fed rice in including the lake basin counties in the former of Nyanza and Western provinces where there exist suitable climatic conditions. However, we find that adequate water supply development and rehabilitation of irrigation infrastructure poses a significant challenge in some of these areas. There are also issues concerning the provision of health care services, land ownership rights and environmental concerns need to be addressed. In the case of rain-fed lowland ecologies, the main challenge is erratic rainfall, inadequate skills for both farmers and extension staff and, infrastructure development. Other issues in such environments are poor soil fertility, rice diseases (especially blast) and pests (Quelea birds and rodents).

3.5 Rice Intensification systems in Kenya

Based on the policies mentioned above rice production in the Kenya- LVB is expected to embrace systems of rice intensification (SRI) and scaling leading to better rice productivity through the use of higher-yielding varieties, better agronomic practices, enhanced pest and disease control and use of tolerant or resistant varieties. Further by expanding the area under irrigation and better water management rice cultivation be developed using improved mechanization methods in the water-scarce LVB, thereby reducing the conversion of the fragile and sensitive wetland ecosystems in the region. We also observe that farmers suffer many fields and post-harvest losses which should be reduced by suitable application of post-harvest technologies, improved cultural practices, developing and application of better and timely harvesting and post-harvest handling techniques and equipment. It is our understanding that farmers in the region lack access to credit and high-quality inputs and are unable to use appropriate rice germplasm to enable them to maintain and plant good variety. There are also limited facilities and inputs needed for production, distribution and marketing of good quality seeds which must be available in good times to ensure good yields.

Good rice growing that involved application of SRI needs fully functional research and extension infrastructure with appropriately packaged and dissemination technologies through a network for information sharing and capacity improvement among farmer organizations, extension and other stakeholders. Rice growing is an environmental and health sensitive enterprise mainly when done in or close to ecologically sensitive wetlands under constant stagnant water, hence considerations for environmental impact assessment and routine audit as well as regular monitoring and evaluation (M&E) are desirable. Therefore it is valuable to understand all stages of rice production, processing and marketing to address any existing gaps.

The actual rice production and cultivated area figures for 2008, 2013 and 2018 from four rice-producing regions in Central, Coast, Nyanza and Western provinces are presented in Table 3.3 and Figure 3.1. The projections are based on rehabilitation and planned expansion of the NIA schemes

with the infrastructure needed to increase rice production under irrigation. The rain-fed rice production will be expanded by growing NERICA seeds and other high-quality seed (Agricultural Economic Review 2008; National Irrigation Board Strategic Plan 2008 – 2013 and Vision 2030). Figure 3.2 shows that the local market prices are progressively increasing from Ksh 3,500 in 2008 to 4500 per 50 kg bag in 2018 with a continued rising trend in price.

Table 3. 3 Current Rice Production and projections based on Area, Yield and Consumption in 2008 by Agro-ecological Condition

Year	Rainfed Upland			Rainfed Lowland			Irrigated			Total		
	Area (ha)	Yield Tons/ Ha	Prod (tons) Total	Area (ha)	Yield Tons/ Ha	Prod (tons)	Area (ha)	Yield Tons/ ha	Prod (tons)	Area (ha)	Yield Ton/ ha	Prod (tons)
2008	2,150	2.72	5848	3180	2.76	8,777	12,500	4.7	58,513	17,830	4.1	73,141
2013	3000	3.11	9330	4000	3.20	12,800	18,216	5,1	92,902	25,216	4.6	115,032
2018	4100	3.70	14800	5950	3.76	18,180	26,000	5.6	145,600	35,150	5.1	178,580

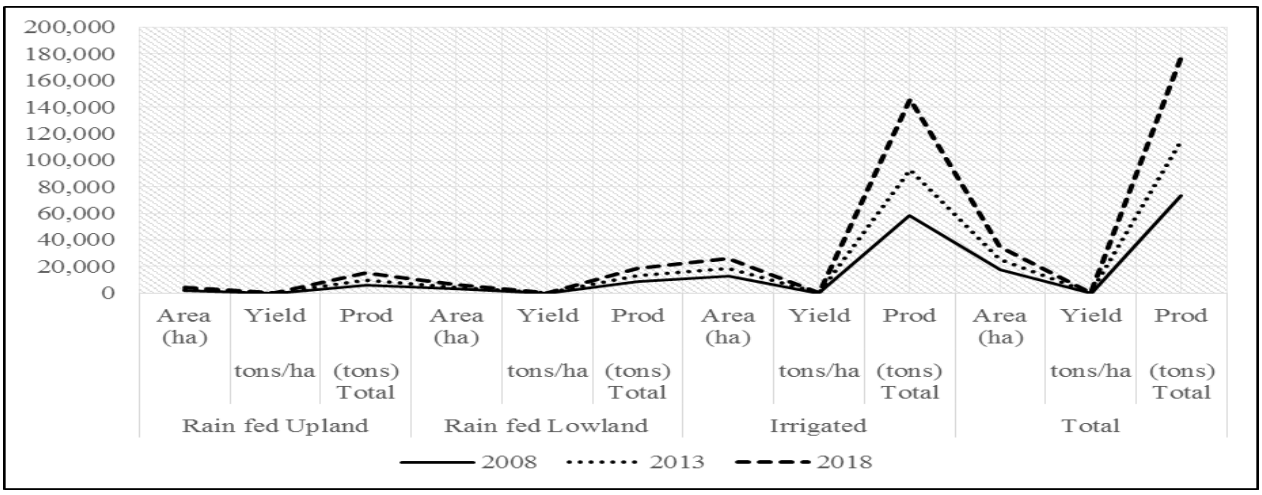

Figure 3. 1 Current Rice Production and projections based on Area, Yield and Consumption in 2008 by Agro-ecological Condition

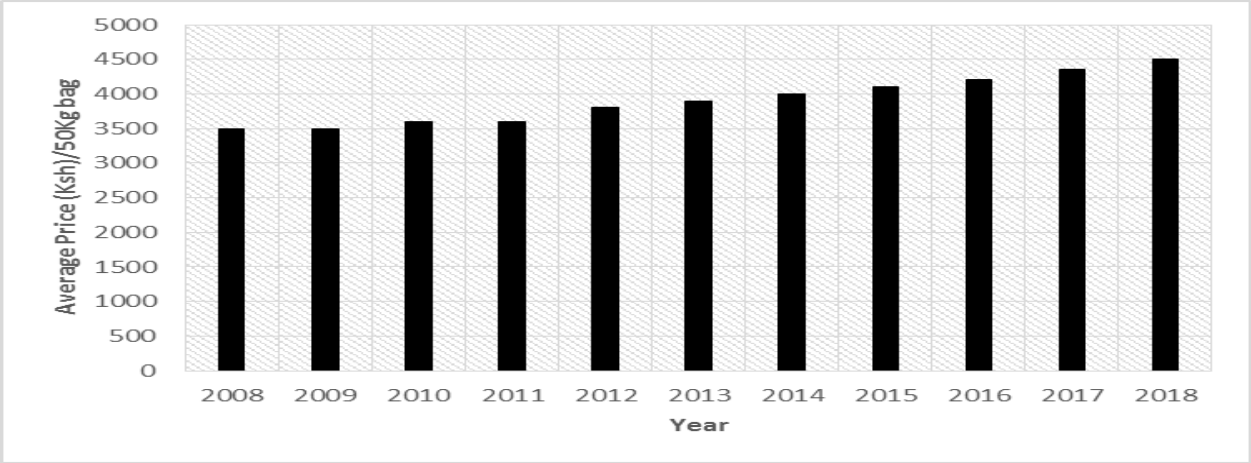

Figure 3. 2 Long term (10 years) target market price of rice

3.6 Popular rice varieties in Kenya

"Sindano", highly susceptible to Rice Yellow Mottle Virus (RYMV) and "Basmati 217" highly vulnerable to blast have been grown since the 1960s. Since then, alternative varieties of both irrigated rice and rain-fed rice have been identified. Table 3.4 shows some varieties of irrigated rice and their characteristics.

Table 3. 4 Varieties of irrigated rice and their characteristics

Variety	Height in cm	Maturity days	Yield T/Ha	Cooking quality	RYMW	Blast
"Basmati 217"	118	122	4.6	Very good	Resistant	Susceptible
"Basmati 370"	118	122	5.3	Very good	Resistant	Susceptible
"IR 2035-25-2"	86.2	128	5.5	Good	Moderately susceptible	Moderately resistant
"IR 2793-80-1"	89	142	6.4	Good	Susceptible	
"BW 96"	68	135	9.0	Fair	Susceptible	Moderately resistant
"UP 254"	84.2	124	6.4	Good	Moderately susceptible	Moderately resistant
"AD 9246."	78.2	128	5.1	Good	Moderately resistant	Moderately susceptible
"IR 19090."	96.6	122	5.8	Good	Moderately susceptible	Moderately resistant

Source:

The upland "NERICA" rice varieties (see Table 3.5) developed at the Africa Rice Centre (AfricaRice) ex-WARDA are resistant to blast, RYMV stem borers and leaf miners and are high yielding. The varieties are now promoted by NIB (National Irrigation Board), Kenya, KALRO and JICA. In Kenya, they have great potential for medium altitudes with high rainfall or possibility for irrigation. "NERICA" can be planted as other small grains, but do need watering especially during flowering, and fertilization.

Table 3. 5 Some features of the NERICA varieties (KEPHIS)

Variety	Optimal production altitude (masl)	Maturity in days	Grain yield (t/ha)	Special attributes
"NERICA 1"	1500-1700	90-100	2.5-55	Aromatic, blast tolerant, long grains
"NERICA 4"	1500-1700	90-112	3.2-6.5	Blast tolerant, long grains
"NERICA 10"	1500-1700	86-93	3.5-6.7	Blast tolerant, long grains
"NERICA 11"	1500-1700	90-105	3.5	High rationing, tolerant to blast and drought, long grains
NIBAM 110	1500-1700	110-120	3.0-5.0	Blast tolerant, RYMV tolerant, long grains, no anthocyanin
IR_05N221	Irrigated & rain-fed lowland	75-90	4.0-6.7	Tolerant to some blast and RYMV strains, good cooking qualities, good milling quality

Source: KEPHIS

3.7 Selected pilot: South-West Kano Rice Irrigation Scheme

3.7.1 Overview

This area was selected for the scaling up study during the stakeholder's workshop in Entebbe, Uganda on 28-29th February 2020 and represents one of the largest rice-growing areas in the region. The rice schemes are located in Kisumu County, where about 90% of rice is grown under irrigation. The schemes are either managed by NIB or independent farmer associations/societies. In the schemes, rice is planted either direct seeding and or by transplanting. Direct sowing is done by broadcasting dry seed or pre-germinated seeds by hand. For transplanting, one needs to produce healthy seedlings which sometimes is not available, and farmers resort to using their seeds or get from other farmers.

3.7.2 The geographical location of the rice-growing area in Kisumu County

The Lower River Nyando Basin is a critical rice-growing area in Kisumu County. It falls in the Nyando River sub-catchment and is at eastern sub-catchments of the Lake Victoria Basin, Kenya. It covers an area of 3,600 km^2 and is situated within the Winam Gulf between longitudes 34° 47" E and 35° 44" E, and latitudes 0° 07" N and 0° 20" S. The SWKIS lies within the Nyando Sub-catchment (Figure 3.3).

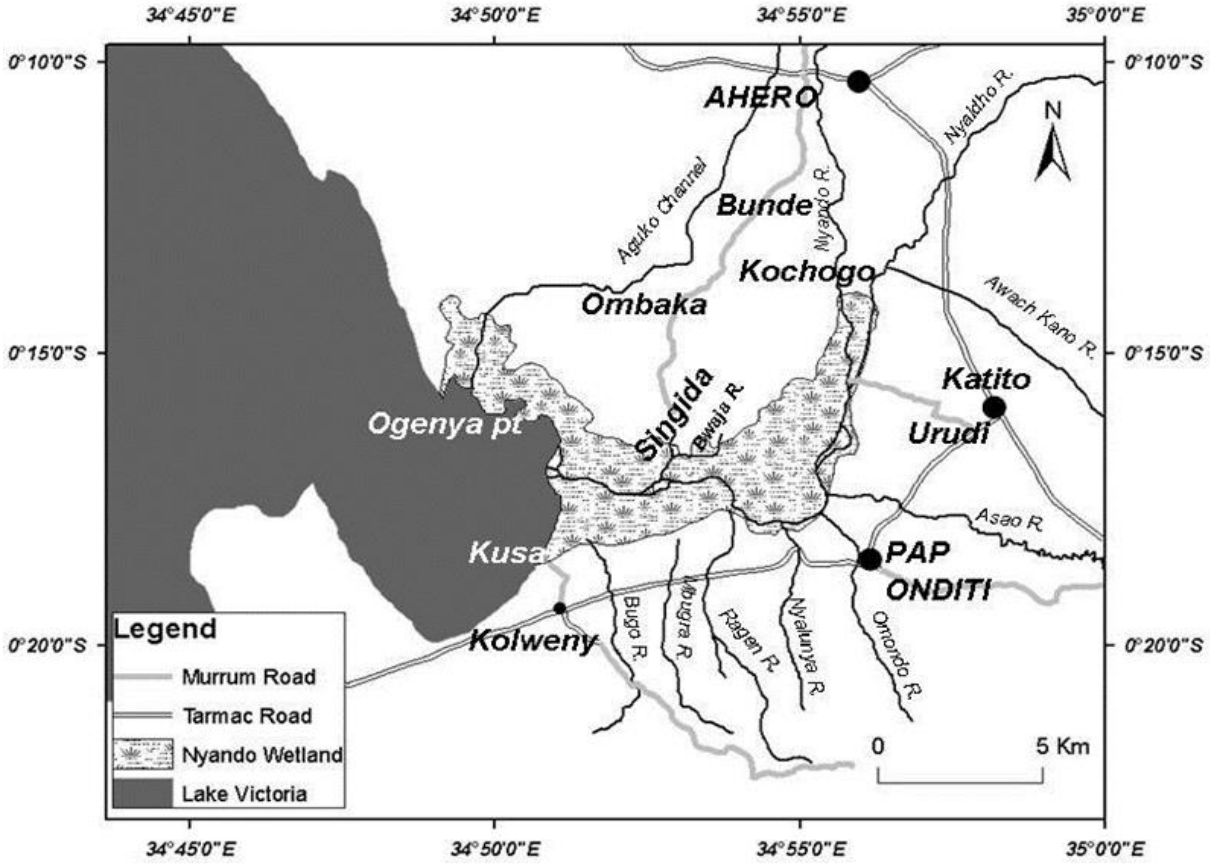

Figure 3. 3 Map showing the location of the SWKIS, Kisumu County
Source: Nasongo S.A.A

The primary land use (Figure 3.4) activities in the catchment include agriculture, indigenous and plantation forests and shrubland which extend through the vast Kano flood plains where key crops such as cotton, rice, sorghum, and sugarcane are grown alongside livestock grazing are common. About 75% of the residents of Kano plains use wetland resources from the papyrus dominated Nyando River Wetland and also engage in small scale farming which has hitherto been an unstable and not economically viable (Nasongo *et al.*, 2015; Jaetzold and Schmidt, 1982). The heavy soils combined with a warm climate, relatively low rainfall and repeated flooding make farming unattractive as an economic venture. Urban centres and industries in the upper catchment include Nandi Hills and Kericho on the upper reaches, Chemilil, Muhoroni and Londiani on the middle-reaches and Ahero near the river mouth.

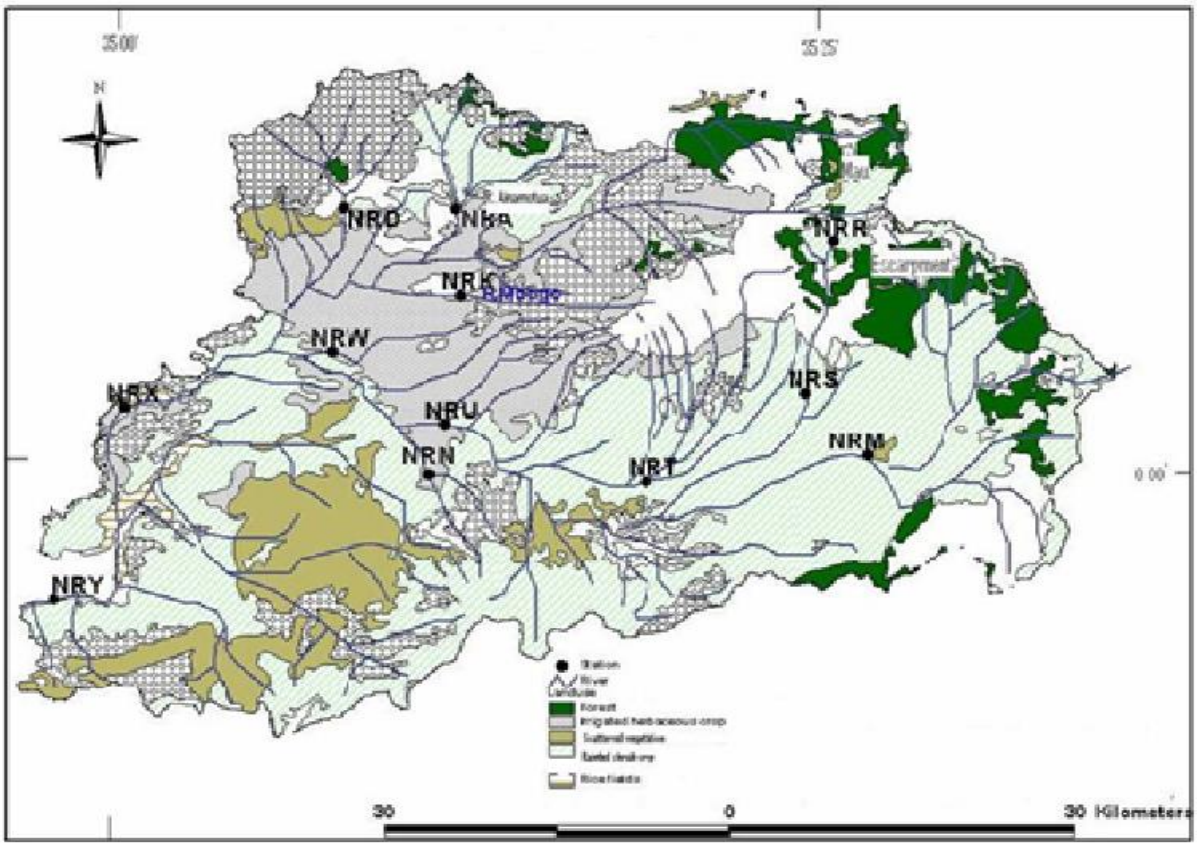

Figure 3. 4 Landuse map of the Nyando River Basin

Source: Raburu, Okeyo-Owuor& Masese, 2009

The Nyando Wetland is a large deltaic wetland which is approximately 14,400ha in size of which the areas at the river mouth fringes Lake Victoria. It covers three administrative sub-counties, namely Nyando, Nyakach and Kisumu East. There are also several isolated wetlands which are in one way or another linked to Nyando Wetlands and depend on seasonal floods of smaller rivers and subsurface water flow. In the Kano Plains, for instance, it is estimated that there are approximately 483 small man-made wetlands in addition to the rice paddy fields of West Kano which cover an area of 436ha (Katua and M' mayi, 2001). The smaller swamps that constitute parts of the Nyando Wetland complex are Okana, Miruka, Nyamware, Rang'ul, Ombeyi, Asawo, Awach Kano, Nyatini, Nyalbiego, Ombeyi, Oroba, Aguko, Obuso, among others. There are also man-made wetlands that constitute the NIA rice irrigation schemes at Ahero and West Kano, and the independent smallholder rice irrigation schemes in Rae, Kabonyo/Kanyagwal, Kochogo, Wawidhi, Kakola, and Kobura.

The Kano Plains occupy two-thirds of the lower half of the Nyando River catchment and are characterized by black cotton and alluvial soils which have poor drainage, and suffer periodic drought and flooding (Millman, 1973). The relief of the Nyando River catchment ranges from 1134m at Lake Victoria to 3000m in the Mau ranges. The general slope runs from north-east to south-west, with lowlands/plateau having a slope range of 0 - 4° and the escarpments a slope of 19 - 43°. Over time Nyando River has changed its course several times traversing the whole of Kano

flood plains leaving behind large silt deposits and traces of former river channels which can still be traced down the trough of Kavirondo Gulf and across the floor of Lake Victoria.
The Kano Plains are characterized by a complex succession in the soil profile and almost in all soils distributed in Kano. Soils in the Nyakach Plain also show a broad variation (JICA, 1992). Most of these soils are non-saline dark coloured clays, and clay loams are the most widespread (Millman 1973). The blackness of soils in both Kano and Nyakach plains is not due to large amounts of organic content. Only a small portion of organic nutrients are present in the topsoil, and characteristic blackness is due to the presence of unoxidized minerals in the soil matrix which are a result of prolonged waterlogging on the plains, during times of floods. When moistened these soils become plastic, slightly sticky and lose any semblance of a structure, and crack on drying to form a weak, angular, blocky structure which is impervious at depth; consequently, topsoils soak up water like a sponge in the rainy season until they are saturated which are problematic to farming (Millman 1973).

The Nyando River Basin experiences a bimodal rainfall pattern with long rains in March-May and short rains in September-November with mean annual rainfall ranging from about 1,100 to 1,600mm with a minimum and maximum mean monthly rainfall of 72mm and 243mm respectively (JICA, 1992). The upper reaches of the Nyando River Basin experience higher amounts of rain as compared to the middle and lower basin. The Kano Plains experience a sub-humid to semi-arid climate and receives rainfall in the range of 600-1100mm/y (FAO, 1996). The Nyando Wetland is a zone of low rainfall experiencing semi-arid conditions (Jaetzold and Schmidt, 1982).

The most notable hydrogeological studies conducted in the Nyando catchment focused on the Kano Plains and was led by DHV Consulting Engineers (The Netherlands) in 1987 and 1988, for LBDA. Data on climate and hydrology in the lower Nyando River catchment may be found from hydrometric and meteorological data by Water Management Authority (WAMA), Kenya Meteorological Department (KMD and private institutions (Khisa et al., 2012). Other reports by LVBC (2006) and studies(Obiero *et al.,* 2012) show that lake levels have been fluctuating at different time scales with a distinct jump from 1133.8m and highest recorded level of 1136.3m during the 1961-62 showers of rain (LVBC, 2006). The recent storms and floods have caused increased water levels by nearly 1.4metres the highest ever experienced since 1962 (LVBC 2020 and J.B. Okeyo-Owuor Personal experience 2020). These have been attributed to climatic factors and among other anthropogenic factors.

3.7.3 Rice production systems in SWKF association

In the study area it was found that land preparation involves (1) ploughing to "till" or dig-up, mix, and overturn the soil; (2) harrowing to break the soil clods into smaller mass and incorporate plant residue, and (3) levelling the field. Although for effective weed control and for enriching the soil, initial land preparation should start after the last harvest or during the fallow period. However, in the South West Kano Irrigation Scheme, the fields are grazed by cattle after harvesting, and land preparation starts late, i.e. 2-3 weeks before planting. No farmers apply herbicides such as glyphosate to kill weeds and for better field hygiene.

Many farmers also maintain standing water at 2−3 cm level for about one week or until it is soft enough and suitable for equipment or manual labour to be used. Tractor and/or draught equipment is used to plough or rotavate the field to incorporate stubbles and hasten decomposition when

practicable and affordable. However, we observed that in many small scale farmers in the study area use either oxen draughts and/ or hand labour during this stage of land preparation. The farmers do not leave the field flooded or submerged long enough (e.g. 32 weeks) to prevent germination of volunteer seeds and weeds hence making transplanting and weeding difficult and expensive. Although different rice ecosystems require different land preparation methods, rice farmers in the schemes employ similar land preparation methods even when soil types are varied.

On the other hand, farmers with a good and reliable irrigation water source prefer to do wet land preparation to enable flooding, making bunds, primary tillage, secondary tillage and levelling. It was also observed that farmers with limited access to irrigation water prefer dry land preparation. In this case, the land can be ploughed well without flooding particularly where rice or other crops have been planted prior and if weed control can be done without flooding. This practice is good because it requires less water, is useful for soil aeration, controlling snails, helps in attaining a smooth and firm seedbed, controls weeds, and incorporates organic materials and fertilizer into the soil. Farmers observed that the method also saves on labour requirements and costs.

3.7.4 Rice Varieties and seed selection

For the farmer to get a good rice crop, it is necessary to use healthy certified seeds of a locally adapted variety, with high yield potential and a reasonable market price. Many rice varieties are being grown in LVB with imported varieties popular in the country obtained from the International Rice Institute in the Philippines and other sources worldwide. The National Irrigation Authority (NIA) and Kenya Agricultural and Livestock Research Organization (KALRO) are responsible for obtaining, clearing and releasing rice seeds in the country. It is worth noting that rice varieties to be supplied to farmers should have good grain quality (especially cooking characteristics, colour, shape, taste and aroma, and head rice recovery). Other characteristics include:

- ✓ High market price
- ✓ Optimum yield potential and stability over seasons
- ✓ Maximum tillering capacity for weed competition
- ✓ Resistance or tolerance to major diseases, insects, and other stresses (i.e. drought and flood) of the area
- ✓ Resistance to lodging under standard farmer management
- ✓ The right growth duration (maturity length) to match the season

Varieties that need to be planted or harvested earlier or later than those in the surrounding rice fields should be avoided to minimize pest damage (e.g., birds during maturation), and growth problems during times of harmful environmental conditions (e.g., late-maturing varieties running out of water). Furthermore, it is necessary to take care of the various factors affecting crop development and management when selecting varieties such as soil type, planting method (e.g. some varieties are better for direct seeding), fertilizer efficiency, amount of rainfall, climate, and disease pressure.

3.7.5 Developing a crop calendar

This is a schedule of crop growing activities in season from the fallow period and land preparation, to crop establishment and maintenance, to harvest and storage. A crop calendar enables proper planning of all farm activities and the cost of production. It allows a farmer to:

- ✓ plan for input purchase and use
- ✓ develop a cash flow budget for the year
- ✓ determine need credit and period requirement
- ✓ determine labour requirements and plan for peak usage times
- ✓ organize contractors for land preparation and harvesting

For the farmer to develop a crop calendar, he/she needs to determine the best date to plant which information may be obtained from local experience, agricultural advisors and leading farmers in the area. It is necessary to decide on the time the variety takes from planting to harvest. Although the length of time from the establishment to harvest is known for each variety, though it may vary a little depending on the growing conditions, especially water availability and solar radiation. Typically, short duration varieties take 100−120 days, medium duration 120−140 days, and long duration 160 days plus. The former should have a growth duration diagram and mark on the calendar the date of planting and when each other operation needs to be done (ploughing, weeding, fertilizing, harvesting). It is also vital to determine how much labour, equipment and finance will be required at each step during the growing period. The farmer should draw the calendar and pin it in a prominent place to remind him/her when things need to be done.

Figure 3.5 shows the months that the farmers are engaged in rice production activities from land preparation to harvesting. Different blocks plant at different times depending on the availability of water with the first batch of farmers starting land preparation in June/July. Rice growing in SWKIS is staggered throughout the year. All the groups interviewed reported to have one cropping season except in one scheme-Abowo where the farmers use the backwaters from the lake to wet the soils and hence manage two seasons. Other factors that determine the start of the seasonal calendar are maintenance of irrigation structures, availability of market to sell the produce and plough back money, finances, machinery and labour especially household labour, the start of the Seasonal calendar set by the block committee, weather and environmental conditions such as drought or flooding. Availability of funds also determines the proper timing of activities throughout the cropping season and subsequently, if the farmer will adhere to the cropping calendar.

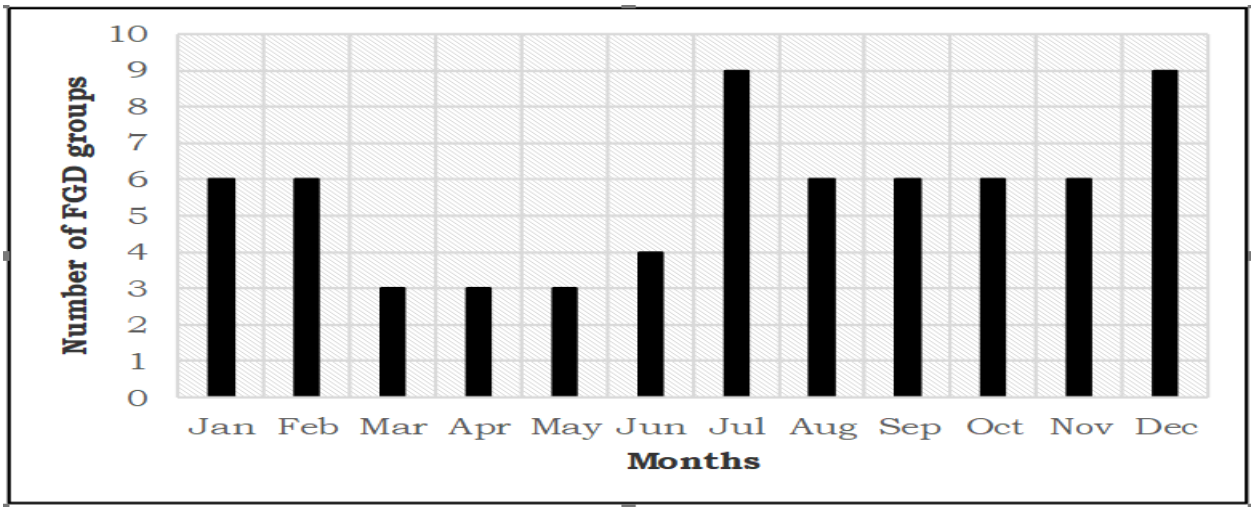

Figure 3. 5 Growing season (Months) for rice in SWKIS

Source: FGD –ScaleWAYS Scoping study 2020

3.7.6 Sources of rice seed varieties and seed quality

The seed is the foundation of any rice crop and must be grown, harvested, and processed correctly for best yield and quality results. Good quality seeds are usually uniform in size, full, and plump; while poor quality seeds are often discoloured. Planting good quality seeds leads to lower seed rate, better emergence (>70%), more uniformity, less replanting, and vigorous early growth which helps to increase resistance to insects and diseases, and decrease weeds. Planting good quality seed can lead to yield increase by 5−20%. Generally, the qualities used to classify rice seeds are varietal purity, seed viability and moisture content. Varietal purity tests include looking for the percentage of (1) germination, (2) other varieties mixed in, (3) weed seeds and other crop seeds, (4) inert material (stones, soil, etc.), (5) red rice seeds, and (6) moisture content. Adult males and females primarily make seed selection in the household.

Although the use of certified seed for rice growing is recommended, most rice farmers fin the study area source their seed from in NIB, recycle their seeds leading to lack of uniformity in the crops grown by farmers and sometimes such seeds are not cleaned and have admixtures with weeds, seed importers and breeders. We also noted that there are local dealers selling rice seeds in the local towns and markets. It is worth noting that internationally IRRI has a significant responsibility to develop suitable rice varieties that benefit many rice farmers and consumers and are well known in various schemes in the study area.

There are different varieties grown in SWKIS with the most popular being IR 2793, as shown in Figure 3.6 below. These include short early maturing rice varieties commonly known by local farmers as "ayar" to mean IRRI. Arize 6444 Gold and Arize Tej have recently been introduced by Bayer Kenya while AT 058 widely referred to as Afritech Seed Company introduced Atieno Atieno. Basmati requires less water and hence is typically grown where there is inadequate water though the most significant limiting factor has been losses to birds since it is aromatic. Most farmers recycle their seed to reduce costs and thus prefer non-hybrid seeds. This reported as the main reason for better acceptability of IR 2793. With the continued introduction of other varieties, farmers will change their mindset towards embracing change.

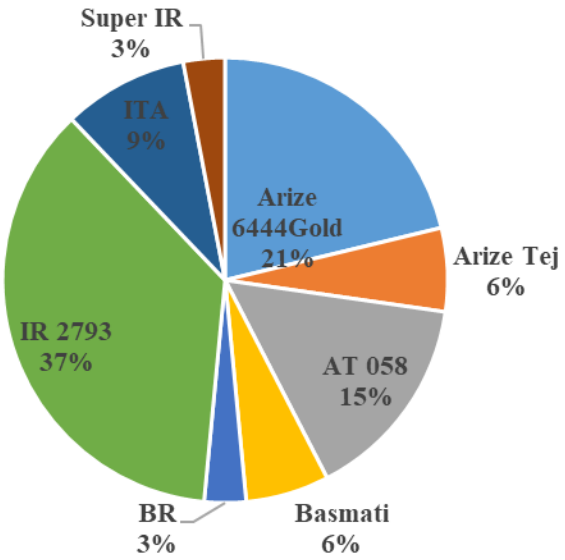

Figure 3.6 Rice varieties commonly grown in SWKIS

Source: FGD –ScaleWAYS Scoping Study 2020

3.7.7 Planting of rice crop

Rice can be either direct-seeded or transplanted. In direct seeding, seeds are sown directly in the field. While in transplanting, seedlings are first raised in seedbeds before they are planted in the main field. When choosing a suitable planting method, the (1) locality, (2) type of soil, (3) rice ecosystem, and (4) availability of inputs and labour, should be considered. It is crucial to choose when to plant for better establishment and growth of the crop in the field. Timely planting into a well-prepared seedbed will help produce a fast-growing, uniform crop that will have higher yields and better competition against weeds and other pests.

The best time to plant depends on locality, variety, weather, water availability, and the best harvest time. Planting at the same time (or within a 2-week window) as the neighbouring fields can help to minimize insect, disease, bird, and rat pressure on individual fields. Direct seeding requires 60−80 kg of seeds per ha while transplanting requires only 40 kg per ha, at two plants per hole. The number of plants established, and its seedling vigour will affect the competitiveness of the crop against weeds, and determine the final yield potential. Transplanting may be appropriate if the farmer has space for a nursery when the resources for seedbed preparation are available, and labour or equipment for transplanting are not limiting factors.

On the other hand, direct seeding may be appropriate if resources are limited, there is a need to reduce labour costs, and the crop is to mature faster. Before transplanting, seedlings need to be raised in a nursery. Seedling nurseries usually use 5−10% of the total farming area.

3.7.8 Managing soil fertility, diseases and pests in rice crops

Ordinarily in western Kenya, most small scale farmers hardly apply fertilizers in their rice farms, although it is known that using nutrients on the crop is essential in managing soil fertility, so the plants grow and develop correctly. In the study area, it was found that some soil fertility problems

exist such as poor management of nutrients and nutrient imbalances in the field. There are also site-specific nutrient requirements needed, but many farmers are not sure how to adjust fertilizer use to improve high rice yields since soil testing is rarely done.

The most common fertilizers used in the area have the trade names Baraka, Yara or KELPHOS, which are formulated specifically for rice (Photo1). For example, Baraka planting has the following composition: N: 11%, P: 22%, K: 21%, S: 4%, Ca: 0.1%, MgO: 0.3%, Zn: 0.5%, and B: 0.17%; Baraka Urea is 46% N, while for KELPHOS the composition is N:10%, P_2O_5:17%, CaO: 24%, Sulphur: 12%, and micronutrients (Boron, Copper, iron, manganese, Zinc, Nickel, Chloride and Molybdenum). Farmers also use high doses of foliar such as Easy grow, Osa Rice, Booster plus, Wuxal-macro mix, Yara Vita, and Agrofeeds among others (Photo)

Photo 3.1: Fertilizers used for growing rice in SWKIS

In the study areas, farmers are aware that birds, pests and diseases can cause high yield loses ranging from 30 to complete loss and timely and accurate diagnosis can help reduce such losses. It is worth noting that the best methods for controlling pests and diseases of rice are through preventive measures. But farmers in the area are more worried about bird invasion in their rice crops which occurred at the critical stages of the plant and need scaring an activity which is often expensive and tedious.

Photo 3.2: Samples of Pesticides and foliar feeds used in rice growing in SWKIS

3.7.9 Managing water in Rice Fields

Farmers in the study area grow rice in small bunded fields which are mostly continuously flooded up to 7−10 days before harvest, which helps to ensure sufficient water and control weeds as required in lowland rice. Nevertheless, many farmers are not aware of seasonal water requirements for an irrigated lowland rice production system despite available scientific information estimate that seasonal water use for rice fields varies from 400 mm in heavy clay to more than 2000 mm in coarse-textured (sandy or loamy) soils with deep groundwater tables. Typically water needed for irrigating rice in Asia is about 1300−1500 mm. Due to its semi-aquatic nature, rice is susceptible to water shortages.

To effectively and efficiently use water and maximize rice yields, farmers should follow good water management practices. It was observed that this occurs where rice is grown under the NIB and in cases where the water source is reliable and sufficient. In the study area there are two sources of water used to irrigate rice crops, pumped water from River Nyando and Lake Victoria and wear and major canals developed by the Dutch funded Small Irrigation Support Organization (SISO) (formerly) Provincial Irrigation Unit for farmer South West Kano not served by NIB system. In these cases m both main canals were constructed by either NIB or development partners in case of government (PIU) or SISO (donor funding and maintained by NIB and farmer organizations.

Construction and maintenance of feeder that enables large amounts of water distribution into paddy fields and also allows drainage is the responsibility of farmers' organizations or farmers themselves. The team found that in areas with heavy black cotton soils, much water may be lost during land soaking before puddling when huge and deep cracks are present. Therefore some farmers prefer to till their land before soaking in water. Furthermore, farmers practice soil puddling to reduce excessive water loss in clayey and cracking fields. Wet land preparation can consume up to a third of the total water required for growing rice in an irrigated production system. Farmers also engage in land levelling to enable farm uniformity and ensure–proper water management. We found that these operations are expensive where labour is used, and many farmers prefer to use mechanized rotavators for both puddling and levelling to ensure complete water coverage and soli uniformity to facilitate rice transplanting. Farmers also use hand labour to construct bunds and repair any cracks or holes to minimize water loss as well as stop rats and plant feeding insects from destroying rice seedlings and ensure proper crop establishment.

Only a few farmers were found to practice alternative wetting and drying (AWD) methods to conserve water instead of continuous flooding. Except in the NIB rice schemes water shortage is a problem in some farms located away from the main water and feeder canals which sometimes was found to cause conflicts between rice farmers a situation that complicates water use management by the local societies. On the other and some farmers ensure water adequacy in their rice crops by illegally opening canals and redirecting water to their farms at night.

3.7.10 Transplanting and weed management in rice crop

Although some farmers still transplant rice seedlings randomly, the study found that many have adopted line planting with relatively uniform spacing. Farmers recognize that the latter methods make transplanting easy and ensures proper water and management and ease of weeding. The latter is used when the seedlings have delayed in the nursery to try and achieve maximum harvest and is also faster than line planting. Direct seeding of rice is rarely practised in the study area but may be found in other regions such as Kuria in Migori County where rainfed rice is grown.

Alternate Wetting and Drying (AWD) can help in water management is hardly employed by many farmers in the schemes studied. After flowering, during grain filling and ripening, it is recommended that water level should be dropped to about 15 cm most farmers are aware of this requirement but rarely practice it and prefer to flood their farms until the crop reaches maturity. Farmers explained that weed control is a primary practice since lack of it leads to high yield losses, production costs, and lowering grain quality. In the study area, most weeding is by hand labour and usually expensive. They observed that although weeding management can be done during different stages of rice growing such as during land preparation, in the nursery and during early crop growth majority of farmers do weed rice by hand after the transplanted crops have established and turned green, i.e. at about 30cm above water level.

They argued that weeding during land preparation though might be valuable is mainly successful when farmers have proper land preparation equipment or if they can also use herbicides. Some farmers reported that herbicides are too expensive and unavailable in the market when they require to use them. Further, they are not well trained on the methods of formulation and application of chemical herbicides. It is also worth noting that control methods using herbicides vary depending on the rice ecosystem, planting method and the type of herbicide and the farmer's knowledge. Using herbicides for weed control is useful, especially when labour is scarce, and wage rates are high. Many small scale farmers stated that they use household labour to weed their rice due to lack of cash and that mechanical weeding is uncommon due to lack of such weeding equipment.

3.7.11 Rice harvesting, transport and storage

At rice maturity, farmers use sickles to cut mature panicles and straw above ground which are then stacked/ piled/heaped and left in the field to dry. Cutting and hauling of rice is usually done by men. Hand threshing separates the paddy grains from the rest of the cut crop parts. The grain is cleaned by removing immature and unfilled and non-grain vegetation and other inert material. Nevertheless, harvesting systems vary depending on location or region and can be done using a wide variety of traditional, semi-mechanical, and mechanical tools. Depending on the crop's condition, and availability of labour or machinery, cutting is done either manually or mechanically,

but in the study area, it was found that cutting is done by hand and the use of mechanical harvesters is only being introduced. Following threshing rice grains are put in bags for transport and storage.

Most farmers in the schemes sell their rice to middle-persons; mainly women or cartels at farm-gate who provide bags of different sizes and shapes and have different names such as Pobop (extra-large), Long' (large), and Chania (Bag used for chicken feed), among others. Women who thresh rice are paid either in cash or kind (rice measured in medium-size basins locally called nyaum pusi"- the nose of a cat) while men prefer cash payments for all operations in the rice farm. The bags full of harvested rice are transported from harvesting sites to the waiting vehicle by strong young men (*Shogi*) at the cost of KShs 400per 80-90kg bag. In the field, rice harvesting activities are labour-based, and some activities such as field drying and stacking/piling in small scale farms may lead to yield loss and rapid quality deterioration. Traditionally rice harvesting was done during the day, but we found that this practice is now done at night which does lead to losses since many threshers are not reliable and hide grain in the chuff to be collected later. Farmers provided various reasons for the change in harvesting time.

Rice farmers in the study areas lack proper storage facilities for harvested rice grains hence their preference for sales at farm-gate to intermediaries or cartels who over-exploit them. An excellent storage facility provides safe conditions for the grain to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and fungi. It was found that most farmers sell all their rice in the field and rarely leave any for home consumption. Rice farmer hardly dry their grain after harvest, and some even sell wet rice grains believing that it increases sale price. Usually, rice buyers remain with the task of drying the rice they have purchased. It is worth noting that drying reduces the grain moisture content to a safe level for storage and is the most critical operation after harvesting a rice crop since high moisture level in the store may cause grain discolouration, encourage the development of moulds, and increase attack by pests as well as reducing rice seed germination rate. Paddy drying methods include traditional and mechanical systems but only traditional sun trying is common in farms and milling areas which involve use of papyrus mats polythene and incase of NIB, and LBDA mill pavement drying grounds are available for drying.

3.7.12 By-products of rice in western Kenya

The primary by-products of rice are rice straw, rice husk or hull, and rice bran. Rice straw is a rice by-product produced when harvesting paddy. Each kg of milled rice produced results in roughly 0.7–1.4 kg of rice straw depending on varieties, cutting-height of the stubbles, and moisture content during harvest. In the study area, farmers separate rice straw from the grains after manual threshing. The rice husk, also called rice hull, is the coating on the grain of rice which is formed from hard materials, including silica and lignin, to protect the seed during the growing season. Rice bran is generated when brown rice moves through the whiteners and polishers. When paddy is hand-pounded or milled in a one-pass Engleberg steel huller, rice bran is not produced separately but mixed with rice hulls. One hundred kilograms (100 kg) of paddy rice will generate approximately 5−10 kg of bran and is a mixture of substances, including protein, fat, ash, and crude fibre. Bran composition is largely dependent on the milling process. In modern rice mills, several different kinds of bran are produced such as coarse bran (from the first whitening step), fine bran (from second whitening step) and polish (from the polishing step).

Polish consists of part of the endosperm and is often referred to as meal. Rice bran has a high nutritive value and is an excellent source of vitamins B and E as well as small amounts of anti-oxidants, which are considered too low cholesterol in humans. Rice bran contains 10−23% bran oil, which naturally makes it an excellent binder for animal feeds and when stabilized and extracted, is a high-quality vegetable oil for cooking or eating. Rice bran is vital as an ingredient for animal feeds, in particular ruminants and poultry. In recent years, however, advances in stabilization techniques have been made which has led to new uses for bran and its derivatives, most notably bran oil for cooking and waxes for cosmetic products.

In the study area, farmers are beginning to realize the importance of various rice by-products such as straw, rice husk or hull, and rice bran. We observed that after harvesting, many farmers leave straw in the field to be grazed by wandering livestock or burnt. In western Kenya, farmers are not concerned with the use of rice husk or hull, and rice bran since whole rice is bought by traders and taken to millers who apart from milling remain with these valuable by-products which they sell to livestock farmers and traders for making livestock and poultry feeds among other products. We found that there is generally a lack of appropriate technologies for value-adding for various essential by-products from rice at the farm level and local mills leading to wholesome sales without processing. Rice farmers in this area do not benefit from such products

3.7.13 Rice milling and marketing in LVB

Milling is a crucial step in post-production of rice, and the main objective is to produce edible rice free of impurities by removing husk and bran layers. In Kisumu County, there are two major rice mills located at Lake Basin Development Authority (LBDA) in Kisumu and NIB-Ahero. These mills process high-quality rice which is supplied to supermarkets and local retailers. Additionally, there are several small privately-owned single pass or two-stage "Engleberg" type mills especially in Ahero town, Katito, Nyang' ande, Rabuor, Riat and Kaluore within the rice-growing areas which mostly process broken rice with reduced market values.

A recent development is the mobile rice mills are not found in these rice-growing area yet. Unmilled rice trade revolves around the significant rice mills and smaller ones stated above as well. Rice value chain also supports numerous small traders, mostly women who buy unmilled rice, mill in local mills and sell to individual consumers, government and private institutions.

Lately, a significant market for unmilled rice surfaced from Uganda who through intermediaries buy paddy from farmers for milling in Uganda. In Kenya-LVB, locally produced rice surpasses imported rice in terms of quality and as mentioned earlier is preferred by consumers. Cases of imported poor quality rice are often fraudulently repackaged in the country, causing unfair competition to local rice in instances where they skip enforcement by Kenya Bureau of Standards (KEBS). However, Kenya is a member of both the Eastern African Community (EAC) and COMESA regional trading blocks. A lot of informal cross-border trade and rice seed movement occurs, which is detrimental to rice sub-sector development even when well managed may create a significant trading opportunity and sharing of germplasm.

3.7.14 Identified rice intensification options in the study sites

OP3 is planning more intensive fieldwork at four sites, one for rice and one for fodder in Kenya for rice. Identify the most promising sustainable intensification options/packages of practices for rice and fodder systems in Kenya. The criteria of the options are high potential in terms of sustainable intensification, mature/well tested, not yet widely adopted and state where these practices can best be studied, i.e. where there is a great potential to expand adoption of methods and where at least experimental experience exists with the techniques.

a. Capacity building, awareness creation & extension services
b. Research on unlocking major rice bottlenecks and creating opportunities
c. Enhanced utilization of high certified yielding and quality seed varieties
d. Enhanced irrigation water management
e. Improved farming inputs and mechanization
f. Improved rice farming systems, crop agronomy
g. Modernized harvesting, post-harvesting and storage methods
h. Improved rice processing methods, marketing and use of by-products
i. Strengthening the role of existing cooperative societies along the rice value chain

3.7.15 Proposed strategies to increase Rice productivity in the SWKIS

1. Develop high yielding, pest and disease-resistant varieties
2. Capacity building of farmers and extension staff on appropriate agronomic practices, agro-processing and value addition
3. Develop resilient rice production and water harnessing and management technologies through research
4. Capacity building for rice research
5. Reduce field and post-harvest losses by (i)Appropriate utilization of post-harvest technologies (ii) Improving harvesting, timing and post-harvest handling techniques (iii)Developing and introducing appropriate harvesting and processing equipment
6. Support for extension and advisory services
7. Developing, packaging, disseminating and promoting appropriate rice cultivation technologies in agronomy, crop protection and biotechnology
8. Strengthening and improving farmer – extension - research linkages
9. Facilitating private sector participation in technology development and transfer
10. Expand area under rice cultivation
11. Enhancing and expanding irrigation infrastructure
12. Increasing the area under irrigated and rain-fed rice production
13. Enhance rainwater harvesting for rice production
14. Improving appropriate mechanization techniques for all rice operations
15. Improve Farmers access credit and high-quality inputs
16. Ensuring appropriate germplasm and variety maintenance
17. Facilitating adequate production, distribution and marketing of good quality seeds
18. Facilitating adequate supply and marketing of high-quality inputs.
19. Ensuring affordable credits to the farmer
20. Facilitating insurance for farmers

3.7.16 Other crops cultivated in the study area

Sorghum

The main land use activities in the catchment include agriculture, indigenous and plantation forests and shrubland which, extend through the vast Kano flood plains. The critical crops cultivated here include sorghum, sugarcane, cotton and vegetables. Cattle and small ruminants, especially goats and sheep, are the primary livestock.

> *"We are using biotechnology to introduce genes into the sorghum plant that can help increase Vitamin A content. So far, we see some good success".*
>
> *Dr. Titus Magomere*

Sorghum is Africa's second most crucial cereal because it is the primary source of daily calories for 300 million sub-Saharan Africans. In Kenya, it is the fifth most important grain crop after maize, wheat, rice and barley. It performs well in most parts of Kenya with best returns recorded in semi-arid areas like in warmer in Lake Victoria shores such as Siaya, Kisumu, Homa Bay, Busia and Migori Counties where it also has a ready market and only takes some four months to harvest. For farmers in the Lake Victoria basin, Kenya sorghum is also one of the few crops that grow well under local conditions since it is naturally drought- and heat-tolerant and except for stem borers (insects) and Striga weed it can give good yields will minimum operations and inputs. Sorghum is a staple food crop and easy to grow, and planting materials exist from those developed by researcher and indigenous sources. Sorghum is a drought-resistant crop that can survive in areas with a minimum 420mm rainfall supply per annum.

The crop requires relatively fertile and well-drained soils but also grows well in high altitude areas with high rainfall although can be susceptible to attack by pests such as shoot fly (*Antherigona socata*) and downy mildew fungal disease in the early growth stages causing yield decline. In Kenya and indeed the LVB the most popular variety (in terms of marketability) is the grey coloured GADAM variety. According to Kenya Seed Co., GADAM it is tolerant to bird invasion, stem bores and foliar diseases. GADAM is an excellent source of malt which is used to produce alcoholic beverages. It is high a yielding variety and matures in 4 months, giving average grain yields of 500 Kilograms per acre. In some farms, the yield goes as high as 1,500 kilograms per acre. Certified seed of this variety and other varieties can be found in major and minor agro-vet outlets in the region.

Farmers in the LVB grow both improved varieties such as Seredo and Serena and local varieties for food and sale. Sorghum is planted by broadcasting the seeds on tilled land with furrows although many farmers prefer row planting at the spacing of 1m x 30cm in areas where rains are scarce. When planted by broadcasting it is recommended to thin the plants at an appropriate stage to leave about 15 cm space in between two stands. Although sorghum is mostly tolerant to many pests and diseases as well as short term flooding, invasion of Quelea bird at the milk and maturity stage is the biggest challenge to farmers since it may lead to severe loses if bird scaring is not done in good time. GADAM variety the EABL is the leading market through its subsidiary the East Africa Malting Limited for use in making a popular beer called Senator Keg. According to a recent report, farmers are currently producing 19,000 tonnes of CADAM sorghum against the company's annual demand of about 30,000 tonnes. EABL aside other markets exists for sorghum through value addition, e.g. by making popular cookies, porridge and even buns, brown bread (ugali) among others. It is estimated that growing good sorghum crop requires land preparation, planting,

harvesting and other miscellaneous costs totalling to about Ksh 30,000 per acre. With proper crop management, an acre of CADAM sorghum will produce about 500 Kilograms in a four-month season providing an income ranging from as low as Ksh50,000 to as high as Ksh400,000 per acre given the price of KShs 33.00 provided by EABL.

Sugar cane

Sugarcane is one of the industrial crops grown in Kenya, mostly the main crop in western Kenya. However, it has been least vibrant for nearly ten years due to the rampant mismanagement of sugar companies. In LVB the primary sugar-growing areas and industries are found in Kisumu, Migori, Kakamega, Nandi and Bungoma Counties all of which have been severely affected by both management and marketing problems, which has made farmer divert their attention to growing pother more profitable crops. Although Kenya can be self-sufficient in sugar production, we find ourselves importing the same products from our neighbouring countries such as Uganda and even as far off as Brazil despite favourable conditions that support cane production and multi-billion sugar industries that exist in this region.

Growing of sugarcane requires high rainfall ranging between 1200mm-1500mm and well-drained sandy, loam and clay are ideal and can tolerate acidic and basic soils, but a pH of 6.5 is perfect. Temperatures range of 20-27^{0}C is suitable for the crop growth. In this area, several crop varieties are available and planted such as EAK 69-47, EAK 70-97, EAK 71-402 and CO 945, released in 1990, N14, CO 1148 and CB 38-22, released in 1998, KEN 82-216, KEN 82-219, KEN 83-737, KEN 82-808, KEN 82-401 and KEN 82-247, released in 2002 and KEN 82-472, EAK 73-335, KEN 85-83 and D 8484, released in 2006. KALRO does research activities on sugarcane at its National Research Foundation, KESREF in Kibos in Kisumu County. In Western Kenya, there are several private and government sugarcane factories the main ones being Muhoroni, Chemelil, Miwani, Sony, Mumias, Nzoia and West Kenya all being public-owned factories. Privately owned factories are Kibos sugar, Sukari, etc.

Sugar cane is mainly grown vegetatively by the use of cane setts/ cuttings, bud chips. Deep land ploughing is necessary to remove obstacles and plant debris. Tractor-drawn implements are prevalent in main sugarcane growing areas to help in achieving the required tilth especially in the dry spell to avoid the formation of "hardpans", for proper drainage and root penetration into the soil. There are two planting methods, namely ridge and furrow, flat methods which are preferred due to moisture retention. Planting occurs at the onset of rain if rain-fed and in the LVB there is no irrigation done for the crop. Some farmers apply diammonium phosphate fertilizer in the planting furrows just before planting to help in the development and growth of roots, enhancing the rapid establishment of the crop while most farmers do not. During growth, many farmers apply NPK as a significant nutrient source for good crop growth and development. Topdressing with nitrogen, N-fertilizers (e.g. urea) is done 30-45 days after planting to promote good tillering and crop growth.

Weeding is done mostly manually, although some farmers use selective herbicides or mechanical weeding where manual weeding is uneconomical. The common sugarcane pests are the early shoot borer, internode borer, scale insects, termites, and whiteflies. The common sugarcane diseases include red-rot, sugarcane smut, ratoon stunting. All of which can be controlled through good agronomic practices including using clean planting sets, etc. although most farmers in the LVB rarely control common pests and diseases in sugarcane plantations. Sugarcane crop is harvested between 9-24 months, using very sharp panga that will not destroy the stump for easy and faster regeneration. Some farmers burn the plant before harvesting to ease the operation, get rid of excess vegetation and drive away any serpents often present in a growing cane. However, there is delayed

harvesting caused by factory managers, and harvesting cartels can lead to significant yield loss and reduction in profit to farmers. Well managed sugarcane field should yield roughly 45-53 tonnes per hectare. Harvested cane is loaded into lorries or tractors and taken to weighing bridges then to the factory where it is crushed to process sugar and its by-products.

Cotton

The county government of Kisumu has become the latest to start the push for reviving cotton farming and marketing to boost the income of farmers within the Lake Region Economic block by opening discussions with experts and stakeholders in the cotton industry. This comes after cotton farmers from Embu County petitioned the national government last year to lift the ban on biotechnology cotton; fearing that the sector could collapse unless they were allowed to access B.T. cotton varieties that can withstand pest attack and does not require spraying.

> *Our renewed interest in cotton farming has been sparked by the expected high demand for Kenyan cotton in the U.S. apparel market, "In addition to the expected high demand, we are also encouraged with the revamped of Rift Valley Textiles (Rivatex) and African Growth and Opportunity Act (AGOA) which will enable us secure the export market for our produce."We are in talks with various experts and have also partnered with Lake Basin Development Authority which has been conducting feasibility studies into the viability of cotton farming in the area. "*
>
> *Prof. Peter Anyang' Nyong' o*
> *Governor Kisumu County*

Maize

Maize farming in Kenya is the backbone of food security in this country. Being the staple food of Kenya, maize is the most planted crop for both cash and subsistence purposes. This crop grows in almost all areas of the country, with different varieties being developed for different environmental setups each passing day. The aim is to come up with a type that is resistant to diseases and adverse weather while also registering excellent yields.

With Ugali, Mukimo, Muthokoi and Githeri being the meals on most dinner tables, it is no wonder that the production of this precious grain through maize farming in Kenya can barely keep up with the demand. The government still imports tonnes of maize from neighbouring countries like Tanzania each year. Maize lethal Necrosis is a disease that is slowly threatening maize production in the country. This disease that is the combination of two viruses is causing wilting and sweeping maize field all over the country by bringing havoc and confusion to farmers who practice maize farming in Kenya in 2020. KALRO have, however, worked on a variety that will be resistant to this deadly disease.

Maize farming in Kenya is practised mainly in counties located in Rift Valley and Western Kenya where it does the best in warm temperature high rainfall areas with loamy well-drained soil. In the recent past, maize prices have tripled rising from 700 to over 3000 KShs/90Kg, which is a welcome increase because maize is mainly a one-season crop in many places in Kenya. Small-scale farmers plant maize in Kenya for subsistence and large-scale farmers for commercial purposes. In the Lake

Victoria shores, maize is grown in the upper elevations by small scale farmers near rice-growing areas. Maize crop production in Kenya has faced many challenges over the years, especially in recent times. Diseases and pest attacks have brought down yields and in some areas causing complete crop loss, leading farmers into encountering severe loses. The government machinery has tried to salvage the situation, but with little success.

Root crops

Sweet potatoes, cassava and groundnuts are common crops grown in the LVB. Sweet potato is a dicotyledonous tuber perennial vine and tuber crop which grows well in different agro-ecological zones and is widely grown on a small scale mainly in subsistence farming. In recent times many farmers in western Kenya have been growing it for commercial purposes. The tubers are a rich source of the flavonoid anti-oxidants, vitamin A, dietary fibres and minerals. Locally sweet potatoes are boiled or roasted and eaten either alone or with other foods such as milk, porridge, soups or grains. The sweet potato vines are a useful fodder crop, especially in the dry season**.** In Kenya, where climate change is affecting amount and rainfall patterns, sweet potatoes are a more weather resilient crop. It is a low-input crop making it ideal for many smallholder households; plant rarely requires pesticides or fertilizers. The production presents an opportunity for farmers to improve their food security situation and income from the sales of surplus.

The sweet potato grows well at altitudes up to 2100m above sea level and is occasionally found as high as 2400m especially in lower and mild elevation zones and best in the annual rainfall of 750-1000mm annually although other varieties are drought tolerant. Sweet potato varieties differ from one another in the colour of the tuber skin (usually white, brown-yellow, reddish-purple), the colour of the tuber flesh (typically white or yellow), shape of the tuber, shape of the leaves, depth of rooting, time of maturity, resistance to disease and other vegetative characteristics. Varieties whose flesh is yellow-orange coloured have high levels of carotenes used in the synthesis of vitamin A. This is particularly important in parts of Western and Nyanza regions where Vitamin A deficiency is prevalent. Other improved varieties grown in the country include SPK 013, SPK 004, Kemb 20, Kemb 23, Kemb10, KSP 20, KSP 11, Mugande Muibai, Ex-Diani, Mafuta, Japanese pumpkin and CIP Selection, 420009. There are three primary planting methods used by farmers, namely, a cluster of vines in one mound and ridge planting (single and double row).

Although the crop is weeded at an early growth stage, it generally does not require fertilizer application**.** Sweet potato tubers are harvested for food and marketing through different methods. Some communities also harvest tender vines for vegetable use while in many cases the mature vines are collected and fed to livestock. The ability of sweet potato to establish ground cover very fast enables suppression of weeds such as Striga control of soil erosion and maintenance of soil fertility makes it an essential crop for Kenya's farming systems. Sweet potato is consumed by many Kenyans of all classes at home or in hotels and is regarded as a nutritious food since they are grown without chemicals hence is a healthier dietary choice. They contract the farmers and purchase their tubers at wholesale prices on the farm. Sweet potato tubers are relatively cheap for households and serve as a good substitute for bread and cakes, and its demand is increasing countrywide and beyond as entrepreneurs venture into sweet potato processing. Other Opportunities in the Sweet Potatoes Enterprise include seed bulking, livestock feed, industrial uses and production of composite flours.

Cassava is an indigenous crop that is fast growing and well adapted to the dry environment and local plant diseases. The starch-filled roots are used like potatoes or ground into flour, while the

leaves can be used like spinach. For local communities growing cassava will not only reduce famine but increase the economic level of the people. Cassava is an outstanding staple food for consumption and income generation for farming communities in Western Kenya, where it is mostly grown and consumes 60% of the national cassava production. In years 1994 – 1995 cassava production was drastically reduced due to infections by a virulent form of cassava mosaic disease. In response to the magnitude of the problem, Kenya Agricultural Research Institute (KARI) now KALRO and the International Institute of Tropical Agriculture (IITA)collaborated to mitigate cassava mosaic disease and other important agronomic characteristics.

Over 34 million stems from primary sites have been distributed to farming communities leading to increased cassava crop growing area by improved varieties to over 13,000 ha, which is 38% restoration of the crop. Today over 300,000 households are growing improved cassava in Western Kenya. Fresh cassava tubers and processed cassava products are now available on local and urban markets in the region as famine and poverty have been addressed to a greater extent in the region.

Vegetables and fruits

There are wide varieties of exotic and indigenous vegetable crops grown in the area. Most of the vegetables are sold in the major markets of Kisumu and Nairobi. The most common vegetables grown after the rice has been harvested are butternut, Capsicums, cowpeas, and kales. The most common fruit grown is watermelon which is increasingly becoming a popular crop.

3.7.17 Political economy for rice value chain rice in the study area

In Kenya, the government is focusing on irrigated rice and is planning significant investment over the coming years, including the large-scale expansion of existing schemes in central and western Kenya. A conservative estimate is an additional 20,000ha of irrigated rice land in the next five years, which will more than double the current rice area and production. The main risk is water availability. Water is already a national political issue, and climate change presents a more significant threat to Kenya than to other countries in the region. Basing food security on large irrigation schemes is a policy which may benefit from a more comprehensive review of medium-term water policy.

The most significant obstacles to change are the vested sector interests and ideologically-motivated opposition to change. Vested interests include rice importers who currently profit from high mark-ups under the Common External Tariff (CET) policy regime and those who oppose efforts to liberalise intra-regional trade. Corrupt local government officials, who benefit from the multifaceted export licensing regime and the opportunity to tax shipments, may also resist attempts to ease the bureaucracy. Ideological opposition comes in two forms. First, political dialogue supports small businesses and smallholder farmers. Clearly, any change must show that it will not threaten smallholders and small businesses; instead, it must show that it is expedient for them and creates new jobs and opportunities. Second, concerns about national food security. The rice trade in the region could mean that valuable rice stocks may be exported for higher profit when they are needed to supply home markets. Thus, any change in the sector faces the risk that future-policy making intended to support food security will disrupt the sector. If the regional rice sector is to have a favourable policy environment in the long-run, governments must begin to treat rice as a tactical growth and trade business.

At the local level during the election of scheme leaders and directors, there is a conflict of interest in scheme leadership influenced by clanism. The equitable distribution of resources at the national level affects the running of National Irrigation Authority offices and at local level tractors and infrastructure development is diverted to preferred schemes. Policy formulation on the marketing of rice and cooperative development at the County and the National Assembly is complicated since most elected members are not rice growers. Government policies do favour the rice farmer, e.g. importation of cheaper rice from Pakistan. There is a conflict between the Fisheries department, chiefs and MCA and rice farmers over the use of wetlands for farming since the former consider them wetlands and fish breeding sites while the latter see them as farms. For example, the MCA attempted to stop rice production in favour of fish farming but this stalled (Kabonyo fish farm). Chiefs are not working closely with the farmers in the blocks. Maintenance fee is not paid due to political incitement by politicians who only make empty promises to farmers, especially during electioneering during when there is an acute shortage of labour for rice growing. Excavation of water channels sometimes done by local politicians MCAs hence will allocate machinery to areas where they have a following.

Due to dormant of cooperative societies, there are wrangles in sharing of farm implements among the officials SWKIS, politicians dictating the market structures, e.g. they collude with the middlemen and women hence dictate the price of rice, politicians take advantage of grants and government farm implements provided thus making them a tool for politics.

3.7.18 Stakeholders in Rice Production

Stakeholders in Rice value chains in South West Kano Irrigation scheme, the key actors, influencers, and supporters include is shown in Table 3.6

Table 3. 6 Stakeholders in Rice value chains in South West Kano Irrigation scheme, the key actors, influencers, and supporters

1	Name	Role in the rice production chain	
	Lake Victoria Basin Commission	Provide regional support, linkages and fund raising	
2	Ministry of Agriculture, Livestock & Marketing	Policy making and enforcement	
3	Ministry of Water, Environment & Irrigation	Water resources management & irrigation support, environmental protection	
4	National Rice Stakeholders' Forum (NRSF	Priority setting and implementation of interventions identified in NRDS Collaborate with regional and international rice stakeholders and partners. Participates in regional and international rice development initiatives	
5	Water Management Authority (WAMA)	Water resources management	
6	National Water Harvesting Authority	Construction of dams to harvest storm & rain water for future use	
7	National Environment Management Authority (NEMA)	Ensures environmental management & protection	
8	Kenya Bureau of Standards KEBS),	Ensures standards are maintaints for quality	

		assurance	
9	Kenya Plant Health Inspection Service (KEPHIS)	Protection noxious diseases & observed quarantine regulations are met for introduced germplasm or planting materialks	
10	Kenya National Bureau of Statistics (KNBS)	Generates and maintains statistics on issues related to rain production	
11	County Governments (Kisumu, Busia, Migori & Homa Bay)	Extension and farmer technical support	
12	Regional Rice Center of Excellence.	Regional responsibility for promoting rice value chain	
13	National Cereals and Produce Board	Provides farm inputs & purchase of milled rice & other cereals as national reserve	
14	National Irrigation Board	Irrigation water supply & maintenance of major canals	
15	Lake Basin Development Authority	Support farmers growing raifed rice crop, milling & marketing milled rice	
16	Kenya Agricultural and Livestock Research Organization	Research on rice varieties, agronomy and other value chain	
17	Universities (Rongo, Maseno, etc.)	Research & extension on rice varieties, agronomy and other value chain & other technical aspects	
18	NGOs (VIRED International, etc	Provide technical s& extension services to farmers	
19	CBOs (Nyachoda, Nyadek, etc)	Group management and ensuring compliance with the requirements. Also identify sources of input to farmers and bring them closer to the farms at the right time	
20	Cooperative Societies (WKFIS, Rice Growing Schemes & Blocks, Water Users Associations)	Group management and ensuring compliance with the requirements. Also identify sources of input to farmers and bring them closer to the farms at the right time	
21	International Research Institutes (IRRI, IITA, ASARECA, WARDA, and JICA)	Research on various rice production systems and linkages with both international and NARS	
22	Banks and financial institutions (Equity, KCB, Coop Banks, AFC, Banks and MFIs)	Loaning rice farmers	
23	Rice processors	LBDA, NIB, Dominion farms & mediou and small scale millers in markets	
24	Rice traders and merchants	Official & independent middlemen, National Trading Co & Cooperative societies	
25	Rice transporters	Transport from farm to buyers and millers	
25	Agrochemical firms & Service providers	Sales of fertilizers, herbicides and pesticides	
25	Rice seed producers and stockiest	National Irrigation Board	
	Agriculture Technology Development Centers (ATDCs), KIRDI and JUA KALI sector)	Research & development	

Table 3. 7 Actors in the rice value chain in Ahero Irrigation Scheme

Actor	Specific actors in the area	Specific functions

Input suppliers	NIB, NCPB, Local agro vet dealers, Seed breeders (Afritech, Bayer East Africa etc.)	NIB is a supplier of certified rice seed to farmers in the scheme. NCPB supplies subsidised government fertilizer to farmers organised in groups. Local Agro- vets supply fungicides and pesticides.
Producers Small scale rice farmers-tenants	Rice production in the area.	Grow rice in a designated block under SWKIS
Aggregators/collectors	Smallholder rice self-help groups and 1 Cooperative (Ahero Cooperative society)	Assist in the production and marketing of rice. Groups are majorly production support oriented. Cooperative collects and markets members produce. Help members buy inputs in bulk and give advances/loans.
Traders	Local traders and small millers	Buy rice majorly from farmers at the farm. They work closely with brokers in collecting rice from farmers. Theymill and supply local shops and open markets in nearby towns
Processors	NCPB, WKRM, LBDC, Local millers	Buy rice in bulk from Cooperative societies and some groups—mill and sell to institutions and leading supermarkets. Local millers buy in small scale and supply milled rice to Local shops, markets.
Wholesalers	Large millers, Cereal traders.	Buy milled rice from large commercial millers (Government millers) and supply retail shops within the area, especially in Kisumu city.
Retailers	Urban shops,Open-air markets	Buy rice from wholesalers and millers in the area Operate small shops and outlets. Pack rice into small quantities and Sell rice to consumers in rural area sand in cities as well as rural areas.
Consumers	Rural, urban and institutional consumers	Buy and consume rice.

3.7.19 Constraints, Challenges of the Rice Development

In most rice farms in several constraints and challenges occur and vary according to production, cropping and farming systems across the region. As in many parts of the region, the trend in growing rice is going towards water use efficiency and conservation. Therefore paddy rice growing requires appropriate irrigation infrastructure, which is usually expensive and beyond the scope of most smallholder farmers. During this study, we identified several challenges in rice production in the LVB-Kenya. The land tenure system is a problem in many rice-growing schemes. For instance, we found that almost 70% of rice is cultivated in wetland areas which officially has not been allocated, farmers.

Consequently, the lack of ownership documents and title deeds makes it impossible to access credit and subsidized farm inputs, especially from the government. Further rice growing near or in reclaimed wetland areas causes human-human conflicts due to ownership and boundary wrangles, particularly after flooding situations. Human-wildlife conflicts occur when hippos and other wetland ungulates destroy rice farms without intervention by the Kenya Wildlife Services, who

argue that farmers have invaded environmentally vital wetlands, wildlife habitats, and fish breeding areas.

It was also noted that although women are critical players in rice production, they do not own land and, in many cases, benefit least from the rice harvests compared to men. Hence, women may not actively participate in rice-growing where land tenure does not assure them of benefits for their work nor be willing to invest in sustainable rice production and the use of improved techniques that enables intensification and scaling up. Rice production without the use of machinery is labour-intensive, making labour a critical resource and requirement in rice growing in LVB. Consequently, rice farming is faced by an acute labour scarcity due to urban migration by the young, energetic people, and competition from farming activities of other crops. Further observations show that most young people opt to engage in motorbike transport systems (Bodaboda) and fishing deemed to be less laborious and more profitable compared to toiling in mud and water. The subsequent move of energetic young people to urban centres leaves the elderly to engage in rice production, a situation which makes labour expensive and scarce; therefore, most farmers rely on family labour for various farm and rice-growing activities. Moreover, some families choose to grow rice only when work demands other activities are low.

Rice growing in the region falls under two systems; Ahero and South West Kano Pilot Irrigation Scheme under the National Irrigation Authority (NIA) and South West Kano Farmers Society (SWKFS) under the out-growers. The study finds that mechanization and use of appropriate technologies are practised mainly by farmers supported by the NIA schemes where automation and water supply are assured as opposed to the out-growers where automation and water supply are unreliable. Use of improved rice growing systems by investing in mechanization and other farm inputs, processing, branding and marketing activities in rice-growing LVB areas would create employment and reduce rural to urban migration by the youth, but this process is still lagging. The high cost of farm inputs and machinery is a disincentive to the increase in rice productivity in the Kenya-LVB. Farmers mentioned the problems of land preparation, weeding, bird scaring and harvesting as the most critical and expensive operations they undergo in rice production; as summarised by local farmers in the phrase "mchele mit to pure tek" (rice is sweet to eat but difficult to grow).

In irrigated rice schemes the prevalence of waterborne diseases such as malaria and bilharzia and aquatic parasites leeches affect the productive ability of farmers since they rarely use protective gears insinuating that they are expensive and slow farm operations. Besides, we observed that in recent times rice growing had been hampered by the prevalence of HIV/AIDS and other diseases in the region, significantly affecting the productive workforce of the farming communities. The adverse effects of the COVID-19 pandemic during rice growing period coupled with unprecedented heavy rains and subsequent flooding has posed a significant challenge resulting in crop losses and poor harvests in all areas of LVB.

The situation is exacerbated by the lack of social amenities and improved health care services in most rice-growing areas in the region. For instance, the existing health facilities needed to assist rice-growing farmers in SWKFS such as Nyangánde, Kanyagwal, Ogenya and Ongogosa are either incomplete, dilapidated, flooded, lack the medical staff or not equipped. Inadequate infrastructure, especially in lowland wetland ecologies and uneven distribution of rice mills, has led to a decline in rice production. Infrastructure development such as roads, irrigation and drainage, communication and lack of public /private sector partnerships create a significant challenge for improving rice

farming systems for small scale farmers; who therefore do not realize the real potential for rice production resulting into increased poverty and economic stagnation despite their hard work.

We find that the rice farmers in this area have poor access to credit due to lack of land ownership and or title deeds by farmers in the irrigation schemes and some prefer to lease their land to external growers and in turn, become labourers their farms. It is also worth noting that many rice farmers are disillusioned by the weak market organization dominated by cartels and adulteration of rice. Many rice farmers lack training on appropriate rice production technology mainly caused by a lack of technical and extension staff. We observed that due to lack of storage facilities of unmilled rice at the farm and/or society level and because farmers are not able to process own crop at farm or society levels they are forced to sell their produce at farm gate price to reduce the risks associated with home storage.

Farmers who are cooperative members tend to be more aware of their rights, and as a result, are more empowered to demand results from their leaders. The Government has continued to regard the cooperative movement as a critical pillar of the Kenyan economy, which has led to the enactment of several policies that are amenable to the success of the sector. Many new cooperatives in other commodities, particularly fresh produce, bananas and macadamia are being set up and are projected to grow, but the ones for rice in the region are dormant or have stagnated. Numerous cooperatives were reportedly mismanaged in the 1980s and 1990s, and many of those involved have not been entirely held to account. The mistrust associated with the mismanagement in the 1980s and 1990s still abides, and farmers are reluctant to join cooperatives as a result. As a result of the distrust created by the unions, other farmer-based organisations (FBOs), including Farmers Associations, Common Interest Groups and Producer Business Groups, Rotating Credit and Savings Associations, among others, have been established and many of these have thrived.

However, many still experience vital constraints, including limited skills in business management, bookkeeping, marketing and face limited access to information and finance.

The constraints and challenges are summarized below include:

- ✓ Lack of a viable certified seed production system Inadequate seed supply
- ✓ Inadequate irrigation Infrastructure
- ✓ Low water harnessing skills
- ✓ Little skills/knowledge of rice crop management in newly opened areas
- ✓ High costs of inputs and machinery especially for land preparation
- ✓ Lack of capital and credit provision/facilities
- ✓ Incidences of pests and diseases especially blast
- ✓ Lack of value addition technologies, e.g., good quality milling, parboiling, beverages, and cookies
- ✓ Lack of profitable crop after rice

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4 RWANDA

4.1 The prevailing status and plans for rice and fodder production in Rwanda

Rwanda's agricultural system is dependent on the climatological setting. The country has a bimodal rainfall pattern which results in four annual crop growing seasons: short rainy season starting in September and ending in November; short dry season: December to February of the following year; long rainy season: March to May, and long dry season: June to August. The country has 12 agro-ecological zones (AEZ), which are related in terms of hydro-meteorological and biophysical conditions such as altitude, rainfall, and soil. However, complex farming systems found in the agro-ecological zones due to the diversity of crops with particular crop requirements, cycles, and calendars that impose the boundaries (Mugabowindekwe et al., 2018).

Rice is considered as one of the major staple crops in Rwanda, constituting about 6.9% (with 3.7% produced locally and 3.1% imported) of the entire Rwandan food purchases, after Irish potatoes and beans (NISR, 2011). Other significant crops in Rwanda are maize, sorghum, wheat, and other grains (soy, peanuts, dry beans, peas), cassava, yam, sweet potato, Irish potato, taro, banana, cabbage, amaranthus (*imbwija*, *inyabutongo*, and *rengarenga*). Rice is becoming an important commercial crop with the relatively high sales of 47%, followed by beer banana (39%) and sorghum. Recently, rice has significantly replaced the traditional Rwandan foods such as cassava, maize, and banana, given its remarkable contribution to the improvements not only of income but also the lifestyle of the majority of the Rwandan population, thanks to its ability to provide viable choice as food by qualities of long shelf life and relative facility to be stored and cooked (NISR, 2011).

Taiwanese, Koreans, and Chinese first introduced Rice to Rwanda in the 1960s, but at a small scale (Kathiresan, 2013). Wetlands and valleys were considered most suitable for rice growing, and many farmers and stakeholders in agricultural sectors in Rwanda quickly realized the potential of the crop. With the increased popularity in local markets and knowledge of farmers and scientists, rice cultivation moved from establishments in valleys and wetlands, which was done during rainy seasons, to the current large scale farming in the marshland with several rice varieties are being grown in upland areas (Ntirenganya, 2015). This motivated the government to establish several rice schemes in the late 1990s, especially in the Southern and Eastern provinces of the country. Figure 4.1 presents the increased growth of rice production in Rwanda since the 1960s.

Rice is still grown mainly in marshlands, at an altitude ranging between 800 m and 1200 m above sea level (asl). The annual growing seasons vary from the wet season (March to August in some areas of the country, and January to June in others), and in the dry season (September to January in some areas of the country, and July to December in others) (Kathiresan, 2013). Through the significant investments by the Rwandan governments, many previously uncultivated marshlands have been reclaimed for paddy rice, and improved irrigation infrastructure installed, primarily through the Rural Sector Support Project (RSSP), which established a significant number of dams across the country, majorly for rice crop irrigation. This also enabled most of the Rwandan marshlands to be cultivated throughout the year without interruption by the dry season (FAO, 2017; MINAGRI, 2012).

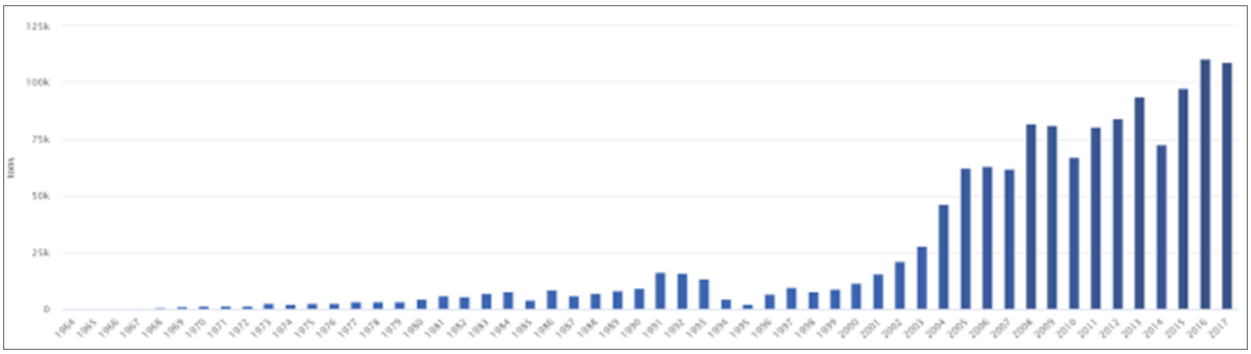

Figure 4. 1 Historical rice production in Rwanda from 1964 up to 2017

Nevertheless, local rice production does not meet the total rice consumption demand by the local market. Therefore, the need to import milled rice to compensate for the gap. For instance, from 2009 up to 2012, the domestic rice production could only suffice for the 51.8% of the local market demand, and the country imported an average of 43,229 metric tons of milled rice from several countries, including, mainly, Tanzania, Pakistan, and Vietnam. Figure 4.2 shows the recorded rice production in comparison with local consumption and imports, from 2000 up to 2012. Figure 4.2 gives the annual paddy rice production in Rwanda.

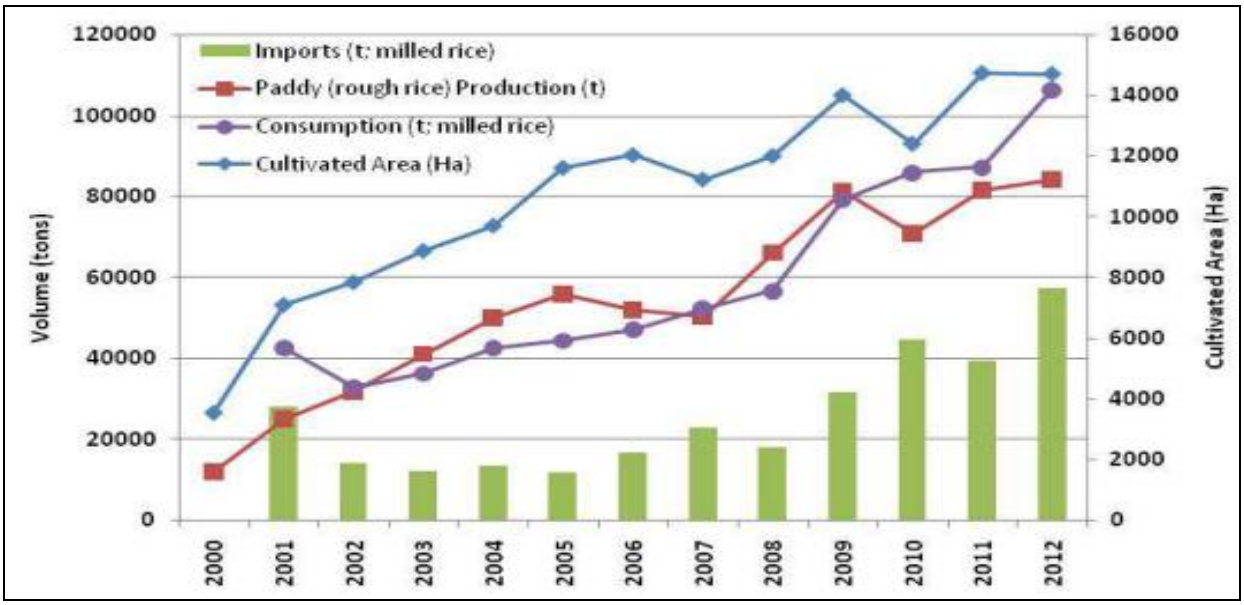

Figure 4. 2 Local rice production, imports, and consumption in Rwanda: 2000 – 2012

(Source: Kathiresan, 2012)

As illustrated in Figure 4.3, there has been a rapid increase in the annual production of paddy rice in the country, reaching about 95,000 tonnes in 2015 from about 60,000 tonnes in 2005. The increase in production is credited to the government's investments in land reclamation for rice cultivation. In the period 2005-2015, yields have not been stable, but between 2010 and 2011, records show good results with over 7 tonnes per hectare, while records other years show ranges between 4 t/ha and 5.5 t/ha. Figure 4.3 summarises the records from 2005 up to 2015.

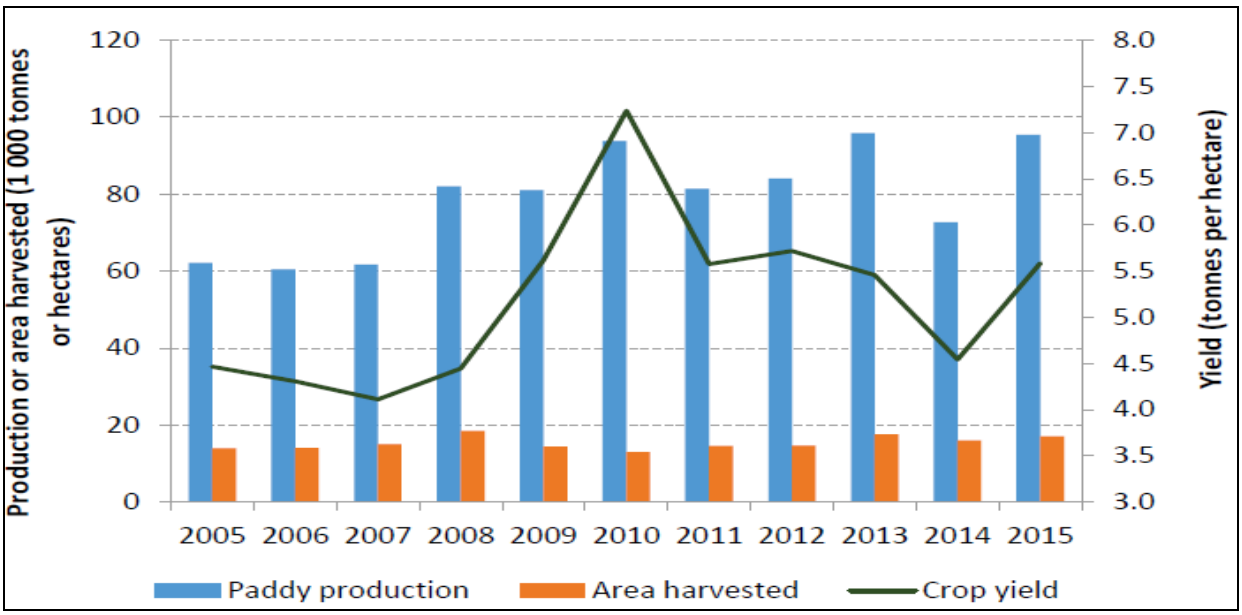

Figure 4. 3 Annual Paddy Rice Production in Rwanda (Source: FAO, 2018)

Because rice is among the crops rated as useful in combating hunger by the Rwanda government, in 2005, the government has prioritized its production (along with other crops such as maize) in wetlands, especially in Zones of Eastern and Southern provinces (WCS, 2019). Moreover, the farmers have been encouraged to use improved seeds and fertilizers to boost production. Other crops prioritized alongside rice are beans, cassava, soybean, maize Irish potato, and wheat (RAB, 2019). Most of the Rwandan farmers have adopted the use of inorganic fertilizers for rice cultivation, which is seen as a critical aspect of agricultural development in the country (Cantore, 2011). The inorganic fertilizers, along with improved seeds and crop protection are the pillars of the crop intensification program in Rwanda and is shown by the remarkable improvements of cost-benefit ratio for Rwandan farmers. Tables 4.1 and 4.2 presents the difference in yield and investment for rice, in intensive agriculture vs. extensive agriculture.

According to the SAS report of the season in the year 2020, non-rice agricultural wetland covers a land of about 55,807 ha making 2.2% of the total Rwandan land. Paddy rice in the wetland area covers about 21,848 ha making 0.9% of the entire country's territory. Rice farmers in Rwanda use both traditional and improved seeds. The NISR Seasonal Agricultural Survey (SAS) report found that in season A of 2020, 35.2 % of farmers used enhanced seeds. Also, 34.0 % of small-scale farmers (SSF) and 87.0% of large-scale farmers (LSF) used improved seeds in Table 4.3 (2013 – 2016) and Table 4.4 (2017 – 2020). Table 4.1, 4.2, and 4.3 indicate that the use of traditional/organic fertilizers has been increasing in Rwandan rice farming through time.

Table 4. 1 Users of Traditional Seeds (%) in Rwandan Rice Farming (2012 – 2016)

		Season A						Season B					
		Kigali City	**South**	**West**	**North**	**East**	**Rwanda**	**Kigali City**	**South**	**West**	**North**	**East**	**Rwanda**
2012	Agricultural Operators	-	0.6	0.0	0.0	0.3	1.0	0.0	0.4	0.2	0.1	0.2	0.8
	LSF	0.3	0.8	0.2	-	0.3	1.5	0.3	0.3	0.2	-	0.3	1.1
2013	Agricultural Operators	-	0.6	0.0	0.0	0.3	1.0	0.0	0.3	0.2	0 .0	0.2	0.8
	LSF	0.3	0.8	0.2	-	0.3	1.5	0.3	0.3	0 .1	-	0.3	0.9
2014	-	-	-	-	-	-	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-	-	-	-	-	-	-
2016	Agricultural Operators	100.0	0.0	68.2	61.7	0.0	64.3	89.3	0.0	100.0	97.0	0.0	95.9
	LSF	-	-	-	-	-	45.5	-	-	-	-	-	51.4

Source: (NISR, 2013; NISR, 2015a)

Table 4. 2 Use of Improved Seeds in Rwandan Rice Farming (2013 - 2016)

		Season A						Season B					
		Kigali City	**South**	**West**	**North**	**East**	**Rwanda**	**Kigali City**	**South**	**West**	**North**	**East**	**Rwanda**
2012	Agricultural Operators	-	3.6	0.1	0.1	0.1	**4.0**	-	9.3	0.1	-	-	**9.4**
	LSF	0.6	1.5	-	-	0.9	**3.1**	-	3.4	-	-	1.4	**4.8**
2013	Agricultural Operators	-	3.6	0.1	0.1	0.1	**4.0**	-	9.2	0.1	-	-	**9.3**
	LSF	0.6	1.5	-	-	0.9	**3.1**	-	3.2	-	-	1.4	**4.5**
2014	-	-	-	-	-	-	**-**						
2015	-	-	-	-	-	-	**-**						
2016	Agricultural Operators	0.0	0.0	39.4	41.9	0.0	**39.7**	10.7	0.0	0.0	9.0	0.0	**7.4**
	LSF						**69.7**						**60.0**

Source: (NISR, 2013; NISR, 2015a; NISR 2015b; NISR, 2016b)

Table 4. 3 Users of Seeds (%) in Rwandan Rice Farming (2017 - 2019)

		Season A		Season B	
		Traditional Seeds	**Improved Seeds**	**Traditional Seeds**	**Improved Seeds**
2017		42.6	57.4	87.5	12.6
2018	Agricultural Operators	27.79	72.21	43.22	56.78
	LSF	21.3	78.7	27.7	72.3
2019		91.8	40.9	65.6	34.4
2020		27.7	72.4		

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 4 Source of Improved Seeds (%) in Rwandan Rice Farming (2017 – 2020)

	Season A								Season B						
		RAB/ Sector (Gvt)	**Recognized seed Multipliers**	**NGOs**	**Agro-dealers**	**Market**	**Agri. Coop.**	**Other sources**	**RAB/ Sector**	**Recognized seed multipliers**	**NGOs**	**Agro-dealers**	**Market**	**Agri. Coop.**	**Other sources**
2017	Agricultural Operator	9.9	7.9		45.6	-	-	36.5	7.9	25.2		9.4	-	-	57.5
	LSF	20.3	69.5		3.4	-	-	6.8	12.8	83.0		2.1	-	-	2.1
2018	Agricultural Operator	1.0	11.7	5.5	0.7	-	81.1	-	10.2	23.5	0.9	5.3	1.3	58.4	0.4
	LSF	10.2	79.7	-	6.8	-	3.4	-	5.9	82.4	-	1.5	-	3.4	10.3
2019		4.1	60.8	1	-	-	34	-	1.2	69.9	1.2	4.8	-	22.9	-
2020		0.8	38.6	-	3.2	-	57.5	-							

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

The SAS 2020 season A report states that the primary sources of improved seeds used by farmers are agro-dealers (36.6%), NGO/companies (28.8%), government (16.5%), cooperatives (6.1%), market (5.4%) and seeds multipliers (5.4%) (Table 4.5). Table 4.6 presents different ways in which rice farmers used their produce from 2014-2020 (season A). The main uses of rice produced in Rwanda include sale, stored, food for farmers, the wage for hired labour, farm rent, and fodder; there is also a damaged portion (which is minimal).

Table 4. 5 Use of Rice Production (%) in Rwanda (2014 – 2020)

		Season A											Season B										
		Sold	Stored	Auto-consumption	Used as wage for hired labour	Used as Farm rent	Offered as Gift to Other	Exchanged with other things	Used as seeds	Used as fodder	Damaged	Used in any other way	Sold	Stored	Auto-consumption	Used as wage for hired labour	Used as Farm rent	Offered as Gift to Other	Exchanged with other things	Used as seeds	Used as fodder	Damaged	Used in any other way
2014	Agricultural Operators	66.9	1.1	24.9	1.6	0.4	2.7	0.2	1.8	0.0	0.2	0.3	62.3	1.6	28.4	0.9	3.4	0.3	3.0	0.0	0.0	0.1	0.1
	LSF	71.2	0.1	24.6	0.0	0.0	0.0	0.0	1.1	0.0	2.9	0.0	79.5	0.0	19.3	0.0	0.0	0.2	0.0	0.9	0.0	0.0	0.0
2015	Agricultural Operators	63.6	0.4	26.8	1.3	1.4	2.6	.2	3.3	0.0	0.4	0.0	70.9	0.0	24.1	0.9	0.1	1.7	0.1	2.2	0.0	0.0	0.1
	LSF	84.5	0.0	14.1	0.9	0.0	0.0	0.0	0.4	0.0	0.1	0.0	84.5	0.0	14.1	0.9	0.0	0.0	0.0	0.4	0.0	0.1	0.0
2016	Agricultural Operators	71.7	23.2	1.2	0.1	1.5	0.0	2.0	0.0	0.3	0.1	0.0	45.0	0.0	45.0	1.0	1.8	3.1	0.0	3.9	0.0	0.0	0.0
	LSF	84.5	14.1	0.2	0.0	0.0	0.0	0.9	0.0	0.0	0.1	0.0	82.1	0.0	17.5	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
2019		89.1	0	8.5	0	0	0	0	0.7	-	1.2	0.5	88.8	-	9.5	-	-	-	-	0.8	-	0.9	-
2020		76.0	0.1	19.9	0.7	0.3	0.2	-	0.7	-	2.0	-											

Source: (NISR, 2013; NISR, 2015a; NISR 2015b; NISR, 2016b; NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

4.2 Policies, Institutional framework, strategies, and plans

4.2.1 Vision 2050

Rwanda's Vision 2050 aims to ensure high standards of living for all Rwandans. The main areas of focus for the Vision 2050 include: 1) Quality of Life, 2) Modern Infrastructure and livelihoods, 3) Transformation for prosperity, 4) Enhancing Rwandans Core Values, and 5) International cooperation and positioning. Specifically, in number 3 (Transformation for prosperity), the country aims at increased productivity and competitiveness while providing jobs for Rwandans, a goal expected to be achieved through advancing (i) agro-processing: advanced food industry, technology-intensive agriculture with a commercial focus; diversified tourism; (ii) high value IT and tech services/industry: e.g., electronics; business and financial services; (iii) logistics and aviation: airline, airport, drones, ports, and others. (iv) scientific and technological innovations: e.g., nanotechnology and biotechnology; construction industry; e.g., housing, local materials development, and expansion); and (v) extractive industries (mining, oil, and gas): with focus on value addition

4.2.2 National Agricultural Policy

The National agricultural policy envisions Rwanda as "a nation that enjoys food security, nutritional health and sustainable agricultural growth from a productive, green and market-led agricultural sector." For the vision to be achieved, the mission is "to ensure food and nutrition security, modern agribusiness technologies professionalizing farmers in terms of production, commercialization of the outputs, and the creation of a competitive agriculture sector." The policy outlines four main objectives: 1) Increased contribution to wealth creation, 2) economic opportunities and prosperity, 3) improved food security and nutrition, and 4) increased resilience and sustainability.

The policy actions are organized under four broad pillars: 1) Enabling environment and responsive institutions (recommending avital action to attract investments from the private sector, to driving sector toward commercialization, in recognition of the fact that turning the agricultural sector around will require substantial investment while public finances are getting scarce); 2) Technological Upgrading and Skills Development (the pillar presents a research agenda for closing Rwanda's agriculture technology and skills gap, thus making more people employable, in recognition of the fact that technological upgrading should be at the crux of productivity growth); 3) Productivity and Sustainability (emphasizing on the fact that agricultural production must increase accordingly in order to meet socio-economic and food and nutrition security issues); 4) Inclusive Markets and Off-Farm Opportunities (the pillar promotes improved productivity and inclusiveness of agricultural market systems and increased off-farm opportunities of diversified farm products for domestic, regional, and international markets, in recognition of the fact that efficiently working market systems are deciding factors for consumers, producers, processors, and traders alike).

4.2.3 Strategic Plan for Agriculture Transformation (2018 – 2024)

Rwanda's Strategic Plan for Agriculture Transformation phase 4 (PSTA 4) indicates priority investments in agriculture and estimates the required resources for the agriculture sector for the period 2018–2024. It is the implementation plan of the National Agricultural Policy (NAP) and represents the agriculture sector's strategic document under Rwanda's National Strategy for Transformation (NST 1). This strategy builds on the achievements of the PSTA 3 while envisaging a transformation of agriculture from a subsistence sector to a knowledge-based value-creating sector that contributes to the national economy and ensures food and nutrition security. Throughout the PSTA 4, there is a strong focus on private investments, as it recognizes that investments of private actors must drive agriculture growth. The strategy, therefore, emphasizes a more robust role of the private sector, including farmers, with the government becoming a market enabler rather than a market actor. For example, the strategy plans to reduce direct government involvement in production, processing, and marketing. Besides creating an enabling environment, the government will provide public goods, otherwise undersupplied by the private sector, including infrastructure, research, social protection, and emergency response. To achieve the envisioned impact, PSTA 4 is structured around 4 Priority Areas: 1) Innovation and Extension, with the focus on improving agronomic knowledge and technology in terms of basic research and innovation, primarily aimed at developing improved varieties and breeds. 2) Productivity and Resilience, with a focus on promoting sustainable and resilient production systems for crops and animal resources. 3) Inclusive markets and value addition, seeking to improve markets and linkages between productions and processing. 4) Enabling Environment and Responsive Institutions, providing the regulatory framework by defining and coordinating public sector involvement.

4.2.4 Land Use Consolidation Policy

Land use consolidation policy was implemented for the first time in 2008 by the Government of Rwanda, through the Ministry of Agriculture, as part of the Crop Intensification Program (CIP). The CIP was initiated by the same Ministry in September 2007 to increase agricultural productivity of high-potential food crops and to provide Rwanda with greater food security and self-sufficiency. The implementation of this program involves various components, including Land Use Consolidation as the central pillar, the proximity advisory services to farmers, inputs (seeds and fertilizers) distribution, and post-harvest technologies (e.g., driers and storage facilities). The program is also supported by other initiatives like land-husbandry, irrigation and mechanization infrastructure development to bring more land under production, avoid dependency on the rain-fed farming system and use of farm power in the context of market-oriented agriculture.

4.2.5 Knowledge Management and Communication Strategy in Agricultural Sector

The purpose of the knowledge and communication strategy is to build relationships between the various actors in the agricultural sector, both within and outside MNAGRI, through knowledge and information sharing. It is intended to empower MINAGRI to communicate issues of agricultural transformation in a more innovative and integrative manner through awareness building, knowledge sharing, and training to facilitate the adoption of best practices,

technologies, and approaches and therefore contribute to policy and decision-making processes. The strategy plans that the increasing knowledge and awareness of agricultural transformation to a broader audience will be achieved through the following activities (i) The development of targeted knowledge and information sharing materials to promote dialogue and discourse among development partners and the general public on various aspects; (ii) The promotion of public debates on various issues related to the strategic plan for agricultural change among the stakeholders in the sector; (iii) Engaging media through training to increase their level of awareness and reporting on various issues to targeted stakeholders and the general public; and (iv) developing the capacity of farmers, private sector and other development partners to enable them better participate in the process of agricultural transformation and thus integrate critical issues on transformation into their plans.

4.2.6 Nutrition-Sensitive Agriculture Mainstreaming Guideline

The guideline recognizes that Rwandan farmers link their agricultural activities with their food requirements and nutritional needs. They rely on agriculture for their livelihoods as well as their direct source of daily food. The guideline aims at building on what farming households do intuitively by integrating nutrition sensitivity into policies, programs and plans, by implementing the following approaches (i) Seasonal and or chronic dietary gaps and related health problems should be one of the drivers for agriculture supply chain upgrading; (ii) Value chain interventions need first to use a "do-no-harm" framework to ensure existing cropping systems and their corresponding dietary diversity, as well as gender roles, are valued, preserved and improved; 3. Agriculture project resources have to be programmed to meet both nutrition and income goals.

4.2.7 Law N°005/2016 of 05/04/2016 Governing Seeds and Plant Varieties in Rwanda

The Law governs seeds and plant varieties in Rwanda, and elaborates on plant variety evaluation, certification and registration Committee; Procedures for assessment, certification, registration and withdrawal of a plant variety from the national plant variety list; national plant variety list (previsioning that each year, certified plant varieties are registered on a list provided for that purpose which is published by the Minister in the Official Gazette); Quality seed production, processing, and marketing; Requirements for quality seed producer, conditioner and dealer; Recognized Seed categories (pre-basic seed, basic seed, certified seed, and quality declared seed), among other provisions.

4.2.8 Strategies for Sustainable Crop Intensification in Rwanda

Started in September 2007, the CIP focuses on six priority crops, namely maize, wheat, Rice, Irish potato, beans, and cassava. Under this program, the farmers synchronize the cultivation of crops in lands that are consolidated and rearranged to form more extensive and more rational holdings. Farm inputs such as improved seeds and fertilizers were imported and distributed to farmers through public-private partnerships and extension services rendered to farmers on the use of inputs and improved cultivation practices. As a result, crop productiviy has increased. The production of maize and wheat has increased by 6-fold, and that of Irish potato and cassava has

tripled. The production of rice and beans increased by 30% in the past four years. These outputs have pushed Rwanda to the verge of becoming a secure food country.

4.2.9 Rwanda Irrigation Policy and Action Plan

The Rwanda Irrigation Policy envisions an irrigation sector that is sustainable, dynamic, efficient, demand-driven, and acting as the transforming force in the modernization and diversification of agriculture to create national wealth and food security. The policy is implemented under a mission "Rwanda Irrigation Policy will provide guidance and an environment conducive to the accelerated and sustained irrigation development in Rwanda." Objectives of the policy and action plan include (i) Support the development and expansion of efficient, low-cost irrigation; (ii) Comply with the Rwanda Water Resources Policy; (iii) Comply with the Rwanda Environment Policy; (iv) Create a public utility, the National Irrigation Board (NIB); (v) Create and support national irrigation standards; (vi) Create investment opportunities in the irrigation sector for the private sector; (vii) Empower beneficiaries for effective participation at all levels in irrigation development; (viii) Promote proper irrigation water resource management; (ix) Strengthen institutional capacity at all levels of irrigation development; (x) Strengthen technical support services, develop and disseminate innovations and technologies in irrigation; and (xi) Mainstream cross-sector issues such as gender, HIV/AIDS, environment, health, land in irrigation development.

4.2.10 National Fertilizer Policy

The national fertilizer policy starts with a piece of background information, on Rwanda's targets for agricultural growth of 8.5% per annum as a critical contributory driver to economic growth and poverty reduction in the country, that hinges on agricultural intensification. Nevertheless, Rwanda is characterized by low soil productivity due to nutrient depletion arising from over-cultivation and soil erosion; hence, increased and judicious use of fertilizers must be adopted to achieve agricultural intensification. In this regard, Rwanda targets that fertilizer use of 45Kg/Ha, which translates to 55,000MT of fertilizers, is taken up, which is still below the target as contained in the Abuja Declaration on Fertilizer for an Agricultural Green Revolution of 50Kg/Ha.

The policy outlines seven critical challenges that the agricultural sector is still facing: 1. Low fertilizer use (compared to other countries), resulting in low yields and farm incomes; 2. Inadequate economic returns to fertilizer use due to the narrow range of formulations; 3. Nutrient use inefficiency at the farm level; 4. Lack of sustainable availability and access to fertilizers since few companies are involved in imports, thus limited competition; 5. Lack of effective quality control and regulation in fertilizer marketing and use; 6. Expensive government-led input programs not easy for private companies as the Government cost per ton is too high to support expanded use and requires massive subsidies, directed to few to companies, products, and weak quality control to accommodate more importers, products; 7. Lack of utilization of locally available raw materials for fertilizer production

For the challenges mentioned earlier to be addressed, the fertilizer policy covers the following aspects: 1. Fertilizer Production; 2. Imports and Exports; 3. Fertilizer Trade and Marketing; 4. Promotion of fertilizer use (i. Extension, ii. Subsidies, iii. Agriculture and Rural Finance); 5.

Research and Development (Updating recommendations, Soil surveys); 6. Regulation and Quality Control (standards and others); 7. Environmental Considerations (Increase fertilizer use efficiency (briquettes, etc.), Synchronized applications: timing of applications and split applications); 8. Gender focus; and 9. Governance and Institutional linkages

4.2.11 Gender and Youth Mainstreaming Strategy

The strategy developed by the Ministry of Agriculture and Animal Resources is aligned to the Fourth Strategic Plan for Agriculture Transformation (PSTA4) and also comprises strategic interventions to increase youth capacity and tap their potentials during the implementation of PSTA4. The strategy indicates that agriculture contributes 31% of Rwanda's GDP and accounts for almost 80% of the female labour force, with the majority undertaking subsistence farming, and farming accounts for 33% of all new jobs created in the Rwandan economy. There are high expectations for agriculture, not just to employ a growing rural population but also to generate higher-quality jobs that will reduce poverty.

The strategy draws out the concerns and experiences for women, men, and youth but also pays particular attention to women due to the historical exclusion, the impact of cultural norms and attitudes, and marginalization that women have faced. On average female-managed farms are estimated to be 12% less productive than male-managed farms. The difference has been attributed to the disparity in access to and returns from productive and financial resources as well as to the gender-based differences in the returns that accrued to those productive resources. Closing the 12% gender agricultural productivity gap would create an estimated increase in GDP of USD 418 million and lift a significant number of Rwandans out of poverty. The difference is most evident in off-farm employment (with fewer women accessing these jobs), employment in implementing agencies (where women are outnumbered by almost 50%), financial services, and access to land and agricultural inputs.

Other key factors that drive inequality include farm size (farms managed by women are 10.5% smaller than farms managed by men); lower expenditure on fertilizers and insecticides (female farm managers spend 35% less on these inputs compared to farms managed by men); household size (farms managed by women tend to have larger households and a higher dependency ratio); lower prices for agricultural produce (compared to prices achieved by men); and time spent in formal education.

4.2.12 Agricultural Mechanization Strategies for Rwanda

At its formulation in 2013, the strategy envisioned that 25% of farm operations would become mechanized by 2017, allowing one in every 4 Rwandan farmers to either own and/or hire mechanization services on their farm. Enabling access to the various farm mechanization options, development of technical ability and knowledge on farm types of machinery and implements, and improved agro-processing through mechanization will serve as the key drivers in this transformation. In 2013 mechanized farm operations, including land preparation, planting, crop treatment, harvesting, post-harvesting, and agro-processing, were 13%.

4.2.13 National Rice Development Policy and Strategy (2011-2018)

The Rice Policy has been ratified by the Government to respond to the increase in national rice demand. The policy document defines new ways to enhance the rice value chain. The National Rice Development Strategy is the strategic working document of this policy. The strategy proposes the implementation task force and rice stakeholders' forum to help attain coherence amongst Rice related projects and programs, and provide a forum for consultations on policies and implementation of projects by the various stakeholders along the rice value chain in Rwanda.

4.3 Key players in the production of Rice in Rwanda

The key players in the rice production chain in Rwanda are found in Table 4.6 below

Table 4. 6 Key players in the production of Rice in Rwanda

	Institution/Policy	Functions	Effectiveness
1	Ministry of Agriculture and Animal Resources	• Policy formulation • Inter-ministerial role • Political goodwill • Fund mobilization	• Highly Effective
2	Rwanda Agriculture Board	• Policy implementation and production management • Political goodwill • Fund mobilization • Seeds multiplication and improvement	• Highly Effective
3	Farmers' cooperative societies	• Marketing and utilization chain of the two products; • Post-harvesting handling and production management	• Highly Effective
4	NISR	• Policy implementation • Conducting and leading seasonal agricultural surveys • Permitting agricultural and socio-economic field data collection in Rwanda	• Highly Effective
5	Rwanda Land Management and Use Authority (RLMUA)	• Policy implementation • Fund mobilization especially in land management	• Highly Effective
6	Rwanda Water and Forestry Authority (RWFA) – Department of Water Resources Management	• Policy implementation • Political goodwill • Fund mobilization especially in water management	• Highly Effective
7	JICA	• Fund mobilization • Capacity building	• Highly Effective
8	Rwanda Standards Board	• Policy implementation • Certifying crop varieties	• Highly Effective
9	UN-FAO	• Fund mobilization • Capacity building	• Highly Effective
10	One Acre Fund	• Seeds multiplication • Farmer's field schools support • Capacity building	• Highly Effective
11	IFAD	• Fund mobilisation	• Highly Effective
12	World Bank	• Fund mobilization	• Highly Effective

4.4 Main rice production systems in Rwanda

In Rwanda, Rice is cropped in pure stands, although there are also some mixed stands, as presented by the following Table 4.7 (2014 – 2016) and Table 4.8 (2017 – 2020). However, large scale farmers (LSF) mostly use the pure cropping system compared to intercropping rice with other crops. Table 4.9 presents the average rice plot size (ha) per cropping system (pure vs. mixed agricultural land) as recorded in the 2018 Seasonal Agricultural Survey, where Eastern Province has both the largest average plot size for pure stand and mixed stand cropping system for paddy rice.

Table 4. 7 Distribution of Paddy Rice areas pure areas in SAS Strata (%) (2014 – 2016)

	Season A						**Season B**					
	Strat 1.1	**Strat 1.2**	**Strat 2.1**	**Strat 2.2**	**Strat 3.0**	**Rwanda**	**Strat 1.1**	**Strat 1.2**	**Strat 2.1**	**Strat 2.2**	**Strat 3.0**	**Rwanda**
2014	0.6	-	8.7	7.1	-	**3.2**	0.8	0.0	12.4	83.5	0.0	**4.3**
2015	0.4	-	13.8	57.1	-	**2.6**	0.5	-	10.0	74.3	-	**2.3**
2016	0.1	0.0	2.3	25.9	-	**0.4**	0.2	-	5.3	53.7	-	**0.7**

Source: (NISR 2015b; NISR, 2016b)

Table 4. 8 Share of Pure and Mixed Agricultural Land per Stratum (%) (2017 – 2019)

		Season A					**Season B**				
		Intensive cropland on hillsides	**Intensive cropland in marshland**	**Rangelands**	**LSF**	**Rwanda**	**Intensive cropland on hillsides**	**Intensive cropland in**	**Rangelands**	**LSF**	**Rwanda**
2017	Pure Cropping	25.7	56.2	22.8	95.7		25.8	62.1	17.1	89.5	
	Mixed Cropping	74.3	43.8	77.2	4.3		74.2	37.9	82.9	10.5	
2018	-	-	-	-	-	-	-	-	-	-	-
2019	Pure Cropping										
	Mixed Cropping	-	-	-	-	-	-	-	-	-	-
2020	Pure Cropping	-	-	-	-	29.8	-	-	-	-	-
	Mixed Cropping	-	-	-	-	70.2	-	-	-	-	-

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 9 Average Rice Plot Size (Ha) per Cropping System (Pure vs. Mixed Agricultural Land) per Province (2018)

		Season A						Season B					
		Kigali	South	West	North	East	Rwanda	Kigali	South	West	North	East	Rwanda
2018	Pure	0.15	0.06	0.07	0.07	0.18		0.16	0.07	0.08	0.06	0.15	
	Mixed	0.1	0.06	0.08	0.07	0.20		0.1	0.07	0.08	0.06	0.19	
2019		-	-	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-	-	-

Source: NISR, 2018b

Rice Production areas, their distribution, methods of production, yield levels, production efficiency, demand and, specific production practices

Rwanda's rice farming is dominant in the Southern and Eastern provinces of the country. The Northern Province does not have areas under rice, and but support wheat growing among other crops. The current (2020) seasonal agricultural survey indicates that cultivated area for paddy rice was estimated at 14,507 ha, which is a slight decrease of about 1 % from that of the 2019 season A. In Season A 2019, rice cultivated area was estimated at 14,671 ha, a 13% decline from the 2018 season A records. In 2019 Season B, cultivated rice area, was estimated at 18,225 ha, which is a 9% increase compared to the 2018 season B records. Although few smallholder farmers also grow paddy rice, it is mostly produced by large scale farmers (LSF) who belong to farmers' cooperatives (Table 4.10).

The current seasonal agriculture survey report (2020 Season A) indicates that the average paddy rice yield was 3.6 tons/ha, which decreased compared to the 4.041tonns/ha estimates of Season A 2019. The total production of paddy rice in Rwanda has also been changing through time. The current report of the Seasonal Agricultural Survey (2020 Season A) indicates the Paddy rice production was estimated at 52,225 MT, which shows a decrease of about 12 % compared to the output of 2019 season A. In 2019 Season A, paddy rice production was 59,286 MT with an increased change of 2% from the 2018 season A estimates. In 2019, Season B, paddy rice production was estimated at 72,291 MT with a considerable increase change of 29% from the 2018 season B estimates. Tables 4.11 and 4.12 present the variation of overall rice production in MT across the country, from 2017 to 2020.

Table 4. 10 Area (ha) under Rice Cultivation in SAS Strata in Rwanda (2017 – 2020)

	Season A						Season B					
	Intensive cropland on hillsides	Intensive cropland Marshland	Rangelands	SSF Total	LSF Total	Rwanda	Intensive cropland on hillsides	Intensive cropland Marshland	Rangelands	SSF Total	LSF Total	Rwanda
2017	1,375	3,158	-	4,533	12,389	16,922	1,236	1,953	-	3,189	14,094	17,283
2018	102	6,194	2,445	-	8,198	16,938	413	6,736	2,025	-	7,566	16,739
2019						14,671						18,225
2020						14,507						

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 11 Average Rice Yield (Kg/Ha) per Province in Rwanda (2017 – 2019)

	Season A								Season B							
	Kigali City	South	West	North	East	SSF Total	LSF Total	Rwanda	Kigali City	South	West	North	East	SSF Total	SSF Total	Rwanda
2017	3,981	3,431	3,860	-	3,642	3,572	3,150	3,263	-	3,023	3,558	-	3,304	3,162	3,876	3,744
2018	2,779	3,013	3,774		3,631	-	-	3,420	3,780	2,537	5,136	-	4,054	-	-	3,532
2019	-	-	-	-	-	-	-	4,041	-	-	-	-	-	-	-	3,967
2020	-	-	-	-	-	-	-	3,600	-	-	-	-	-	-	-	

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 12 Total Rice Production (MT) in SAS Strata in Rwanda (2014 – 2019)

	Season A								**Season B**							
	Kigali City	**South**	**West**	**North**	**East**	**SSF Total**	**LSF Total**	**Rwanda**	**Kigali City**	**South**	**West**	**North**	**East**	**SSF Total**	**LSF Total**	**Rwanda**
2017	101	7,535	2,408	-	6,146	16,191	39,026	**55,217**	-	4,722	994	-	4,368	10,084	54,631	**64,715**
2018	284	18,660	9,226	-	29,764	-	-	**57,934**	1,560	17,006	9,533	-	27,846	-	-	
2019	-	-	-	-	-	-	-	**59,286**	-	-	-	-	-	-	-	**72,291**
2020	-	-	-	-	-	-	-	**52,225**	-	-	-	-	-	-	-	**-**

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Another critical factor affecting rice farming in Rwanda is field pests and diseases. According to the SAS report (2020 Season A), some (21.7 %) of small stale farmers applied chemical pesticides to control pests and diseases on Rice in Season A 2020. 20.3 %, while 83.9% of the Large Scale farmers applied pesticides(See Table 4.13). The most used pesticides, countrywide are Rocket, Dithane, and Cypermethrin, used by some 36.0 % of farmers, 23.9%, and 19.4%, respectively.

Table 4.13 Percentage of Plots with Pesticides use per Stratum (2016 – 2019)

	Season A					Season B				
	Intensive cropland on hillsides	Intensive cropland in marshlands	Rangelands	SSF Total	LSF Total	Intensive cropland on hillsides	Intensive cropland in marshlands	Rangelands	SSF Total	LSF Total
2017	7.8	29.1	3.2	40.1	38.0	10.0	23.9	5.1	39	31.8
2018				19.5	67.7				14.29	58.8
2019				16.6	69.7				13.6	65.3
2020				20.3	83.9					

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

4.5 Water management of rice production

Water is one of the vital resources in agriculture, especially rain-fed and irrigated rice farming in Rwanda. In the country, almost 100% of the larger-scale farmers irrigate their rice crops regularly. Traditional irrigation technique accounts for 71.5% action by farmers who source water from underground water and lakes/streams for irrigation with 47.2% and 43.2 % respectively (Tables 4.14 and 4.15). Rwandan rice farmers also face a challenge of soil erosion and sediment deposition in wetlands where most of the rice farming is practiced, consequently, the need by 73.2% of the farmers to implement anti-erosive activities to cope with the present situation (SAS report (2020 Season), with 38.6 % of farmers also practicing agroforestry. Cover plants are commonly used anti-erosion by 58.5% of farmers. Several activities are done by the farmers to fight erosion, which mainly includes ditches, trees/windbreak/ shelterbelt, bench terraces, progressive terraces, cover plants/grasses, water drainage, mulching, beds/ridges, and others.

Table 4. 14 Irrigation Types used in Rwandan Rice Cultivation (%) in SAS segments (2017– 2019)

		Season A					Season B				
		Surface irrigation	Flood Irrigation	Drip irrigation	Sprinkler Irrigation	Traditional irrigation	Surface irrigation	Flood Irrigation	Drip irrigation	Sprinkler irrigation	Traditional Irrigation
2017	Agricultural Operators	99.7		0.3	-	-	99.8		-	-	0.3
	LSF	99.2		0.0	0.0	0.8	98.7		-	-	1.4
2018	Agricultural Operators	11.11	86.99	-	0.3	1.63	13.3	86.4	-	-	0.3
	LSF	-	97.2	-	-	2.8	19.1	80.9	-	-	-
2019		9.6	86.9	-	-	3.5	8.5	88.8	-	-	2.7
2020		23.0	4.9	0.0	0.0	71.5					

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 15 General Sources of used Water for Irrigation in SAS Strata (2017–2019)

		Season A									Season B								
		Rainfall	Rain water harvesting	WASAC water (Treatment)	Undergroun d water	Lake water	Stream water	Recycled water	Dam/Water catchmentr	Other sources	Rainfall	Rain water harvesting	WASAC water (Treatment)	Undergroun d water	Lake water	Stream water	Recycled water	Dam/Water catchmentr	Other sources
2017	Intensive cropland on hillsides	4.4	0.9	7.0	36.8	7.0	32.5	0.9		10.5	1.1	6.3	4.2	22.1	6.3	56.8	1.1		2.1
	Intensive cropland in marshlands	2.4	7.5	-	42.1	0.7	44.9	0.9		1.4	0.9	1.5	-	28.0	4.7	58.6	0.4		6.0
	Rangelands	-	-	-	-	-	100	-		-									
	LSF	1.3	2.2	22.8	42.4	28.1	3.1	-		-	4.3	2.8	-	17.1	22.8	51.2	-		1.9
2018	SSF	0.4		5.02	28.1	57.14		-	9.07	0.4	0		1.7	27.3	60.3		-	10.2	0.4
	LSF	6.16		1.9	14.22	61.14		-	15.64	0.95	2.5		1.5	17.9	57.7		-	13.4	7.0
2019		0.9		3.2	27.6	54.3		-	13.9	0.2	1.5		2.6	28.5	57.6		-	9.6	0.3
2020		2.53		5.15	47.21	43.16		-	1.94	-									

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 16 Percentage of Plots with Anti-erosion Activities use per SAS Strata (2017 – 2019)

	Season A					**Season b**				
	Intensive cropland on hillsides	**Intensive cropland in marshlands**	**Rangelands**	**SSF Total**	**LSF Total**	**Intensive cropland on hillsides**	**Intensive cropland in marshlands**	**Rangelands**	**SSF Total**	**LSF Total**
2017	68.9	74.8	23.2	55.6	69.2	64.9	76.3	21.6	54.3	56.6
2018				68.3	63.5				67.4	61.2
2019				72.4	80.8				73.6	86.6
2020				73.0	84.1					

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 17 Type of anti-erosion activities by stratum (%) from 2017 to 2020

		Season A									Season B								
		Ditches	Trees / Wind break/ Shelterbelt	Bench terraces	Progressive terraces	Cover plants/grasse	Water drainage	Mulching	Beds/ridges	Others	Ditches	Trees / Wind break/ Shelterbelt	Bench terraces	Progressive terraces	Cover plants/grasse	Water drainage	Mulching	Beds/ridges	Others
2017	Intensive cropland on hillsides	13.6	2.9	4.5	9.7	59.2	0.8	3.7	5.3	0.4	11.6	2.5	4.5	11.0	57.4	0.8	4.5	6.9	0.8
	Intensive cropland in marshlands	7.8	1.2	0.2	1.1	22.4	45.3	0.4	20.5	1.1	4.3	0.5	0.3	0.6	18.6	48.1	1.2	25.4	1.0
	Rangelands	24.5	16.3	-	5.4	34.0	0.7	17.7	0.7	0.7	40.7	6.7	3.7	4.4	34.1	0.7	8.2	1.5	-
	LSF	27.7	5.5	5.1	2.7	18.4	28.2	6.7	4.5	1.3	22.4	8.4	6.4	0.5	23.1	24.4	6.7	3.0	5.0
2018	SSF	12.2	2.6	4.2	7.7	51.6	8.9	2.5	10.3	0.0	11.4	2.5	3.7	8.6	52.0	9.4	3.3	9.2	0.0
	LSF	29.4	5.7	3.1	0.4	32.5	18.5	4.7	5.4	0.3	22.1	8.0	5.0	2.0	28.4	23.4	5.5	5.7	
2019		10	3.3	4.8	9.3	51.5	7.5	3.2	10.4	0.1	6.6	3.1	11.9	4.6	54.4	7	4.1	8.2	0.1
2020		6.5	6.0	4.6	9.3	58.5	0.5	1.5	5.6	7.6	-	-	-	-	-	-	-	-	-

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

4.6 Cropping areas, geographical distribution

Background information on rice production

- ✓ **Rice Production-** As of 2012, rice was one of the major staple crops cultivated in Rwanda during dry and wet seasons, mainly in the marshlands over an average area of 7,350.5 Ha. The marshland ecosystem is similar to lowland rainfed ecosystems in Asia. With on-farm productivity of 5.8 tonnes/Ha, rice yields in Rwanda exceed the average level in several other traditional rice-growing countries. However, the local production in Rwanda lags behind the consumption needs of the national market. It is estimated that Rwanda's annual requirement stood at 73,000 tons of milled rice in 2012. The current domestic production can provide only 75% of the yearly national requirement. The deficit is met through the importation of milled rice from elsewhere. With rapidly increasing consumer demand for rice, Rwanda had to produce 204,000 tons of milled rice by 2018.
- ✓ ***Cropping areas, geographical distribution-***Rwanda counts about 29 major/well-established rice schemes across the country. The map in Figure 4.4 presents their geographical locations.

Figure 4. 4 Rice scheme and their geographical distribution in Rwanda
(Source: MINAGRI, 2011)

- ✓ ***Cropping calendars-*** Rwanda has two rice agricultural seasons per year, with the seasons A starting from June/June and end in November/December, and the second season staring from December/January and ends in May/June (FAO, 2018). Looking at the Seasonal Agricultural

Survey of Rwanda, most of the Rwandan farmers sow before September for Season A, before February of the following year for Season B (Table 4.18)

- ✓ **Yields and farm/production economy-**Yields and production economies are critical components of the rice commodity in Rwanda. Starting from the investment differences in intensive vs. extensive agriculture, Table 4.18 indicates that intensive agriculture invests less and provides high yield compared to the extensive agriculture, as reported from the recent Crop Intensification Program in Rwanda. Furthermore, some of the farmers do not have enough financial resources to secure land, and different land ownership categories exist among the Rwandan rice farming (Table 4.20). Additionally, looking at rice crop gross added value (rwf per ha), Table 4.21 indicates fluctuations in the assessed value from 2015 up to 2018. Rice cultivation is a resource-intensive enterprise. Synchronized planting of rice in a given marshland often requires planning of resources such as labour, water, inputs, threshing and drying yards, and storage. The timely availability of these resources also inherently influences the quality of rice produced in marshlands. Smallholder farmers often find organizing these resources difficult and perceive it as a constraint in raising productivity and profitability. Rice farmer cooperatives are established in most of the marshlands to organize communal resources. However, several operational difficulties exist in investing in developing/organizing the required infrastructure such as water canals, drying yards, storage warehouses, etc. and maintaining them

Table 4. 18 Percentage of Rwandan Rice Farmers and Corresponding Sowing Dates (2017 - 2019)

		Season A						***Season B***							
		Before Sep	01-15 Sep	16-30 Sep	01-15 Oct.	16-30 Oct.	After 31/10ct.	Before 31/12	01-15 Jan.	16-31 Jan.	01-15 Feb	16-28 Feb	15-31 Mar	16-31 Mar	After 31 Mar
2017	Agricultural Operators	100	-	-	-	-	-	6.4	22.8		59.2		10.2		1.4
	LSF	100	-	-	-	-	-	14.5	53.0		27.7		2.4		2.4
2018	Agricultural Operators	73.7	13.4	5.4	6.1	0.7	0.7	5.4	12.5	8.6	27.5	28.3	1.1	5.2	1.5
	LSF	94.0	3.6	1.2	1.2	-	-	5.9	23.8	22.8	24.8	12.9	5.9	3.0	1.0
2019		67.6	10.4	5.8	8.7	3.3	4.2	6	18.1	16.9	24.1	17.3	10.8	2.4	4.4
2020		79.8	10.4	4.6	2.9	1.2	1.2								

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

Table 4. 19 Rice average yields and production cost for extensive and intensive production systems

	Intensive Agriculture		***Extensive Agriculture***	
	Yield (kg/ha)	Production Cost (Rwf/kg)	Yield (kg/ha)	Production Cost (Rwf/kg)
Rice	6,800	118	1,800	173

Source: Cantore (2011)

Table 4. 20 Percentage of land ownership category in Rwandan Agriculture in 2019

	Season A			***Season B***		
	Owned	Free lending	Rented by cash or in-kind payment	Owned	Free lending	Rented by cash or kind payment
National	75.8	9.5	14.7	76.6	9.5	14.0

Source: NISR, 2019

Table 4. 21 Rice Crop Gross Added value (Rwf per ha) from 2015 up to 2017

	2015	***2016***	***2017***	***2018***
Gross added value	2,269,385	2,165,030	2,932,325	2,733,423

Source: NISR, 2019

4.7 Rice production efficiency, demand, marketing

The importance of post-harvest handling and processing is not yet fully recognized and is often ignored by rice farmers and processors. As a result of inadequate quality assurance in locally produced rice, the commodity has a low market value in comparison to imported milled rice. There are no clear written regulations on milling operations. There is no routine checking of mills for the standards of operation and outputs. Although EAC countries accept three grades (1, 2, and 3) of milled rice in their markets, rice mills in Rwanda are expected to produce a minimum of Grade 2 rice. Production of Grade 3 rice is prohibited. The government has recently banned small mills that have not adhered to milling regulations and only approves those mills that can produce a minimum of Grade 2 rice. The by-products from milling (husk, bran, and brewers' rice) are not efficiently utilized by the mills, both the private and cooperatives.

The recently set up large and medium rice mills in the country have improved access to paddy markets. Further, the invitation of entrepreneurs to establish new high throughput rice mills will promote competition amongst millers and facilitate transparency in markets. Such privatization measures intend to enable reliable and sustainable access for locally produced rice. The government announces a minimum support price for paddy every season. The government nonetheless allows the millers to provide price incentives (over and above the minimum support price) to those farmers who supply the desired quality features such as the type of rice, purities, and moisture content.

The physical distance between rice-growing areas and the market (mills or traders) determines the accessibility of locally produced rice. Since the ban of small rice mills that previously existed in villages, the rice growers need to be aware of the alternate avenues to markets. Millers and traders, to supplement such efforts, are also encouraged to reach out to farmers in all the rice-producing areas to enable the marketing of paddy grains by the farmers in such marshlands. Price incentives for improved paddy production need to become more transparent and consistent for the rice producers in various parts of the country to sustain the efforts in improving the quality and competitiveness of locally produced rice. It is also essential that the farmers in marshlands have access to timely and accurate market information and the seasonal minimum support price endorsed by the government. Providing strong linkages between components of value chains and

the rice growers will facilitate farmers efficiently access various farm inputs and finding markets where the farmers can sell the outputs.

Rice is replacing traditional staples such as cassava, maize, and plantain, especially in urban areas. The basis for consumer preference is generally the physical and cooking characteristics of rice grains. Consumers in mainstream markets generally prefer long and medium/slender type rice grain. Two types of rice are produced in Rwanda – (i) short and bold (e.g., *japonica* type and *Kigori* variety) and (ii) long and medium/slender types *(e.g., indica* type; Gakire). Due to a strong market preference for the latter, almost all imported Rice into Rwanda is of the *indica* type.

4.8 Technical and socio-economic drivers or limitations for rice production

The land is the main factor limiting rice production in Rwanda. Agricultural growth requires an increase in profits per hectare and the capture of productivity gains along the value chain. To raise profits per hectare means increasing agricultural yields and switching to higher-value agricultural commodities. Currently, the government of Rwanda (through PSTA 4) focuses on facilitating private sector investment in crop production through upgrading provision of quality standards as well as supporting the demonstration of better technologies such as greenhouses, hydroponics, and other small-scale irrigation solutions. Furthermore, infrastructure development has remained problematic for Rwanda due to limited financial capacities and relevant technical knowledge but also limited investment from the private sector. Therefore, a significant proportion of Rwanda's rural population lacks access to transport facilities, including feeder roads. In 2015, only 13,350 km of roads were in a good or passable condition, but Rwanda targets to have 30,000 km of passable roads by 2028. Additionally, the outreach and capacity of service providers remain limited.

4.9 Identified sustainable rice intensification options

The rice production system in Rwanda uses inputs for increased agricultural production. Besides the seeds, farmers also apply both organic and inorganic fertilizers. The current SAS report (2020 Season A), indicates that in season A of 2020, 63.5 % of farmers used organic fertilizer in their farms, with 63.4 % being small-scale farmers, and 68.8% Large-scale farmers. Furthermore, the survey indicates that 34.2 % of farmers applied inorganic fertilizer, with 33.2 % of these being small farmers, and 83.9 % being large-scale farmers. 47.6% of the farmers bought inorganic fertilizers from agro-dealers, 32.2 % of farmers gained inorganic fertilizers from NGOs. DAP, UREA, and NPK are inorganic fertilizers mostly used in 2020 Season A with 41.4 %, 36.2 %, and 18.2%, respectively. The following Tables 4.22, 4.23, and 4.24 presents the use of both organic and inorganic fertilizers in Rwandan rice farming.

Table 4. 22 Use of Organic Fertilizers for Paddy Rice Cultivation in SAS Strata (%) (2014 – 2016)

		Season A						Season B					
		Strat 1.1	Strat 1.2	Strat 2.1	Strat 2.2	Strat 3.0	Rwanda	Strat 1.1	Strat 1.2	Strat 2.1	Strat 2.2	Strat 3.0	Rwanda
2014	Agricultural Operators	7.1	0.0	29.8	15.3	0.0	12.9	25.0	0.0	14.0	20.4	0.0	19.9
	LSF	-	-	-	-	-	57.1	-	-	-	-	-	60.0
2015	Agricultural Operators	0.0	0.0	0.0	2.4	0.0	0.9	14.3	0.0	4.3	2.3	0.0	10.9
	LSF	-	-	-	-	-	30.6						51.5
2016	Agricultural Operators	18.8	0.0	3.0	14.1	0.0	12.4	25.0	0.0	7.7	13.4	0.0	14.9
	LSF	-	-	-	-	-	48.5	-	-	-	-	-	54.3

Table 4. 23 Use of Inorganic Fertilisers for Paddy Rice Cultivation in SAS Segments (%) (2014 2019)

		Season A						Season B					
		Strat 1.1	Strat 1.2	Strat 2.1	Strat 2.2	Strat 3.0	Rwanda	Strat 1.1	Strat 1.2	Strat 2.1	Strat 2.2	Strat 3.0	Rwanda
2014	Agricultural Operators	7.1	0.0	76.6	79.5	0.0	34.7	75.0	0.0	97.7	83.3	0.0	85.2
	LSF	-	-	-	-	-	100.0	-	-	-	-	-	100.0
2015	Agricultural Operators	100.0	0.0	85.5	81.3	0.0	85.3	64.3	0.0	4.3	79.3	0.0	61.5
	LSF	-	-	-	-	-	98.8	-	-	-	-	-	100.0
2016	Agricultural Operators	68.8	0.0	62.1	86.6	0.0	81.8	67.9	0.0	38.5	71.6	0.0	63.6
	LSF	-	-	-	-	-	97.0	-	-	-	-	-	100.0

Source: (NISR, 2015a; NISR 2015b; NISR, 2016b)

Table 4. 24 General Use of Fertilisers in Rwandan Agriculture (%) per SAS Strata (2017 – 2020)

		Season A					***Season B***				
		Intensive cropland on hillsides	Intensive cropland in marshlands	Rangelands	SSF Total	LSF Total	Intensive cropland on hillsides	Intensive cropland in marshlands	Rangelands	SSF Total	LSF
2017	Users of Organic Fertilisers	51.8	45.1	26.2	-	49.9	36.0	35.4	11.7	-	32.7
	Users of Inorganic Fertilisers	15.1	48.8	7.8	-	43.7	12.1	36.2	4.7	-	32.5
2018	Users of Organic Fertilisers	-	-	-	48.15	50.26	-	-	-	38.58	34.56
	Users of Inorganic Fertilisers	-	-	-	24.8	42.8	-	-	-	18.5	33.0
2019	Users of Organic Fertilisers	-	-	-	37.2	1.4	-	-	-	32.4	1.7
	Users of Inorganic Fertilisers	-	-	-	4.2	60.2	-	-	-	5.4	71.7
	Users of both	-	-	-	20.6	30.4	-	-	-	14.5	21.8
	Non-users	-	-	-	38.1	8.0	-	-	-	47.7	4.8
2020	Users of Organic Fertilisers	-	-	-	63.4	68.8	-	-	-	-	-
	Users of Inorganic Fertilisers	-	-	-	33.2	83.9	-	-	-	-	-

Source: (NISR, 2018a; NISR, 2018b; NISR 2019; NISR, 2020)

4.10 The available georeferenced dataset with rice

Rwandan agricultural production systems use a standard "Rwanda land classification," which can be improved after one year (or can be valid for up to 5 years. The cataloging also used in Seasonal Agricultural Surveys done using the Rwanda land cover map, which is a combination of different layers available in the country, in addition to a photo-interpretation of a series (2010 to 2019) of high-resolution satellite images from Worldview. The Rwanda land cover map is divided into 13 land cover classes (Table 4.25).

Table 4. 25 Rwanda Land Classification used in the Rwandan Agricultural Production System

Code	Land cover class name	Area (Ha)	Percentage share
1	Intensive Tea plantations	17,821	0.7
1.1	Hillside agricultural land	1,343,933	53.1
2.1	Non-rice agricultural wetland	55,807	2.2
2.2	Paddy rice wetland	21,848	0.9
2.3	Non cropped wetlands	37,743	1.5
3	Rangeland	144,490	5.7
4.1	Urban settlements	31,612	1.2
4.2	Rural settlements	78,928	3.1
5	Bare land/rocks	15,404	0.6
6	Water bodies	135,295	5.3
7	National parks	241,455	9.5
8	Protected wetland	12,201	0.5
9	Forest	395,001	15.6

Source: NISR 2020

4.11 Approaches for scaling up rice and related water management issues in Rwanda

4.11.1 Policy and institutional, framework and strategies for rice production

The current Strategic Plan for Agriculture Transformation (PASTA4) predicts that the area under rice cultivation should evolve as follows, nationwide, from 2017 to 2050: 33,431 ha (2016), 34,724 ha (2017), 35,199 ha (2018), 39,953 ha (2019), 40,429 ha (2020), 45,183 ha (2021), 45,658 ha (2022), 50,412 ha (2023), 50,888 ha (2024), 55,642 ha (2025), 45,545 ha (2023), 45,545 ha (2035), 45,545 ha (2050). With this increased land for the rice cultivation, the strategy plans that the yield will increase accordingly with the following projections (MT/ha): 3.32 (2016/17), 3.34 (2017/18), 3.36 (2018/19), 3.39 (2019/20), 3.42 (2020/21), 3.45 (2021/22), 3.48 (2022/23), 3.52 (2023/24). Also, the strategy plans that the production will increase accordingly, as follows: 110,824 MT (2016/17), 115,854 MT (2017/18), 118,269 MT (2018/19), 135,286 MT (2019/20), 138,067 MT (2020/21), 155,755 MT (2021/2022), 159,025 MT (2022/23), and 177,584 MT (2023/24).

The total area currently under irrigation is just over 24,000ha, with schemes being developed in the three broad categories of Hillside, Marshland, and Small-Scale Irrigation. Hillside irrigation is mostly characterized by pressurized systems developed on hillside land. The typical design of these schemes is a five-hectare plot with common irrigation infrastructure managed by a group of farmers owning pieces of land within the plot boundary. Technologies such as sprinkler, drip, and improved surface systems are predominant in the hillside schemes. MINAGRI, with support agencies, has embarked on Hillside irrigation development initiatives, mainly in the dry regions of Rwanda. Water is pumped to the surrounding hillsides, and in some instances, gravity diversions from streams and gravity supply from valley dams are used. From a baseline of 162 ha in 2006, the area equipped with hillside irrigation infrastructure has increased to 2,302 ha (MINAGRI, 2012).

Furthermore, the strategy elaborates on the potential opportunities for profitable private sector investments, including, among many others: Investments in high-productive technologies to feed cities: soilless production, hydroponic production, greenhouses/protecting sheds for high-value horticulture products; Public-Private Partnerships (PPP) for improved rice seeds production by rice milling factories (Seeds + inputs + agronomic TA + mechanization) linked with out-grower schemes to feed rice mill factories (scaling up out-grower schemes and contract enforcement); Post-harvest technologies: mobile dryers, warehouses; Aggregation and logistics services for staples as well as niche products; Processing of crop.

4.11.2 Opportunities and constraints for rice intensification and up-scaling

More specifically, Rwanda harbors vast areas of marshlands that could be reclaimed for expanding the area under rice cultivation. For instance, Nyabarongo, a tributary of Nile, provides a total of 5,572.49 Ha of marshlands in 9 administrative districts of Rwanda. With a catchment area of over 2,700 Km2 receiving 1500 mm of annual rainfall, the Nyabarongo River shall support rice cultivation in its swamps. Given the organic nature of soils of Nyabarongo and the success of rice production in similar marshlands, it is tempting to suggest that Nyabarongo marshlands, when revamped, could become a significant 'rice bowl' in Rwanda.

In some marshlands, rice is the only crop that thrives well, especially in the rainy season. Despite the low investment/input nature of rice growing, the high productivity levels render rice production highly profitable in the hands of smallholder farmers. Given the strong demand for rice in local markets, the economic benefits of growing rice over other traditional crops in the marshlands are higher for the stakeholders. The integration of Rwanda into regional economic forums such as EAC further widens the scope of public and private investments and socio-economic viability of Rwanda's rice sector.

Since several international centers and research institutions/universities have long been conducting research and development in rice, several of the technologies that are required for Rwanda's rice production are readily available. Through collaborations with such international centres as IRRI, Africa Rice Center, Rwanda shall quickly identify off-shelf technologies that can appropriately address the needs of rice production, validate and transfer the technologies to farmers. Marshlands such as in Bugarama, where premium rice such as Basmati can be grown, provide specialized ecological niches. If appropriate aromatic varieties that are well adapted to

such local ecologies through breeding and selection, Rwanda can reap rich dividends by tapping into specialized export premium markets such as Europe and North America.

Nevertheless, there are some constraints for the intensification and scaling of rice production in Rwanda. The topsoil in Rwanda's marshlands is highly heterogeneous. The continuous changes in soil profile resulting from the various degrees of soil erosion from the associated hills surrounding the marshes pose a threat to the long term viability of rice cultivation. Lack of recommendations and/or awareness on integrated soil fertility management practices and lack of usage of organic manure in marshlands threaten the production of rice.

The continued cultivation of rice in marshlands has also gradually been building the pressure from pests and diseases. The increased number of outbreaks of pests and diseases in marshes and the inability of farmers to effectively prevent or combat the pests and diseases intimidate the sustainability of rice cultivation by small farmers. The looming consequences of climate change on the rice ecosystems through fluctuations in rainfall patterns, temperature regimes, and human migration patterns further deepen the concerns on raising productivity in smallholder farms in marshlands.

The high population density and a further increase in population constantly challenge the use of land and water for further sharing of these natural resources for agriculture purposes. On the other hand, the rising income levels and the rapidly increasing population also continuously increases the demand for rice in markets, which tend to import rice from elsewhere and thereby rendering vulnerability of the local markets to abrupt changes in global rice dynamics. If the domestic rice sector does not find a stronghold, the increased imports of milled rice grains shall defeat the locally produced rice, which already suffers from lack of competitiveness.

Owing to the recent initiatives on the synchronization of farm activities in marshlands, constraints on labour availability are increasingly felt by rice growers in some marshes. The threat becomes acute during the peak phase of the rice seasons. Since farm mechanization in Rwanda is at an embryonic stage, the labour constraints threaten not only the existing levels of productivity in marshlands but also the profitability of rice cultivation in small farms. The profitability of smallholder rice farming is further threatened by rising fuel costs and the subsequent fluctuations in the price of inputs such as fertilizers.

4.11.3 Key market structures connected to rice production

There are three market categories:

- ✓ **The domestic market,** which is dominated by food crops, and it remains a priority that the domestic agri-food system meets the dietary needs of the population. Improving aggregation and consumer markets (infrastructure, logistics, and market information, among others) is essential both for food consumers and producers. There is a limited but growing market for higher-value niche products in urban supermarkets, restaurants, and hotels. Therefore, standards certification of food products is expected to play an increasingly important role.
- ✓ **The regional market** is also primarily dominated by basic food. Currently, DRC is the leading market for Rwanda's cross-border trade - especially livestock, potatoes, dairy, flour, and edible oils. Within the EAC, continued market integration will expand the Rwanda regional market, and tailored products to EAC consumers will be prioritized. There is a

growing urban market in regional cities, and Rwanda's opportunity may be in selling higher quality products.

- ✓ **International markets** have traditionally been concentrated on exports of coffee and tea. In these traditional value chains, the focus is on improving branding and quality such that the products can fetch higher prices on the global market. Besides, horticultural exports are growing. Currently, the primary market is Europe. However, opportunities have been identified elsewhere – especially West Africa. The emphasis for horticulture will be to improve aggregation, standards compliance, and logistics in the domestic segment of the supply chain. Animal products are the subsequent emerging export sector. Here, there is a need for ensuring animal health to meet standards. For example, a tagging system and livestock database will be required to access broader international markets.

Rwandan rice farmers keep a small portion of the produced rice for family consumption and sell a more substantial part. Rural traders and private millers are the primary buyers of grains from the rice growers. By-products such as straws do not yet have established markets in Rwanda. The accessibility to national/regional markets for both the paddy and the milled grain of locally produced rice plays a pivotal role in sustaining rice production. Rice farmers whose cooperative has shares in the recently established medium-sized mills are obliged to sell 90% of their production to the milling facility. The presence of vibrant, transparent, and extensive distribution networks in the country will reduce the variability in farm gate prices for paddy grains through competition. In the presence of competitive marketing networks, the constant demand for rice in local and regional markets shall also help reduce the volatility in output prices.

Most of the rice growers sell paddy through farmer cooperatives. Although it provides a more secure market for producers, the slow and lengthy procedures involved in trading rice through cooperatives cause long delays in the realization of cash by the producers. On the other hand, the paddy trading network in Rwanda is far too weak and highly fragmented. Rural traders are readily available but often buy paddy from the producers at arbitrary prices. To reduce differences in farm gate price of paddy produced in different parts of the country and to streamline the paddy trading, the government has now begun to set minimum support price for paddy every season. While the MSPs have reduced the disparities in trading values in the country and reduced the meddling by intermediaries, farmers producing better quality of paddy find it hard to receive incentives from the buyers/traders.

4.12 Key stakeholders in rice production

List and categories of stakeholders, their roles and effectiveness

Rwanda's rice sector has made the fastest progress in the region. With the help of the government's investments in marshlands and modest contributions from national and international research initiatives, the local rice production has leaped several folds in the last decade. The sector has grown faster than what the system could handle. For instance, the human and technical capacities in the country are not sufficient enough to provide coherence to the broad spectrum of developments that are taking place in the rice sector (Table 4.26)

Table 4. 26 Number of critical stakeholders (human resources) in Rwanda's rice sector (2008 – 2018)

Year	Rice Researchers			Research Technicians			Extension Workers		
	Full Time	Part-time	Total	Full Time	Part-time	Total	Full Time	Part-time	Total
2008	3	0	3	9	0	9	6	0	6
2010	3	0	3	9	0	9	10	0	10
2011	4	0	4	11	0	11	43	0	43
2013	7	2	9	21	6	27	24	6	30
2018	16	4	20	48	12	60	48	12	60

Researchers are mainly those with a university degree(s), research technicians mostly hold diploma or certificate programs in agriculture-related subjects; extension workers include both professional-grade (diploma/certificate) and university degree holders. The part-time researchers and research technicians include staff working on interdisciplinary programs/units, while the part-time extension workers include mainly agronomists engaged by administrative district/sector work in the rice schemes on a part-time basis.

Rice production and how they affect rice production

In recent years, the Government's investment efforts have been geared towards the reclamation of vast areas of inland valley swamps (marshlands), construction of small dams in the valleys, organization of farmers' cooperatives, privatization of rice mills, farm mechanization and improvement of the supply chain for inputs such as seeds, fertilizers, and pesticides.

Water management tasks and their effects on rice and fodder production

Rice is widely grown as an irrigated crop in Rwanda. Water becomes scarce, especially during the dry season (Seasons A and C) in most of the marshlands where rice is grown. This scarcity is due to either (i) non-availability and/or (ii) inequitable distribution of water. In old marshlands, water availability is a common problem. Due to poor maintenance, weeds and soils clog the irrigation canals. In new marshlands, water equity, especially for rice fields at the tail ends of the water channels, is a significant concern by rice growers. Here the sequential cropping of rice and the general attitude of farmers towards rice as the water-loving crop raises the water demand. In new marshlands, the water is available in adequate quantities as the residual moisture and the water resources are relatively unused and abundant. However, the equitable distribution of water is a significant constraint here. Water equity is often the most fundamental cause of friction amongst the rice farmers in newer marshlands.

The GoR is promoting increased rice production through increased investments in marshland reclamation, reservoir dams, irrigation canals, and drainage systems. In 2012, the total area under irrigation was about 24,000 Ha. This includes 22,554 Ha of marshlands, 100 ha of small scale irrigation schemes, and 1,442 Ha of hillside areas. The government aimed to develop 60,000 Ha of additional irrigated lands (of which two-thirds will be marshlands, and the remaining will be hillsides) through public sector initiatives. It also envisages involving the private sector in developing irrigation infrastructure in the country and has earmarked 20,000 Ha of lands.

Appropriate clusters for rice and water stakeholders (a Community of Practice (CoP))

- ✓ ***Rice farmers***- People engaged in rice cultivation were 44,907 by the end of the year 2009. In Rwanda, rice farmers belong to a total of 60 cooperatives distributed within 29 rice schemes countrywide: Western (2), Southern (12), Eastern (13), and Kigali City (2). Each cooperative covers rice farmers in a watershed.
- ✓ ***Unions (or Federations) and Farmers Cooperatives*** - The agricultural sector has the highest number of registered cooperatives (27% of all cooperatives) as well as the highest number of people (297,996 farmers) operating with cooperatives (Rwanda Cooperatives Agency, 2016), as per 2016. The following table presents the distribution of cooperatives according to economic activity at the national level

Stakeholders in rice production system in Rwanda are shown in Table 4.27-

Table 4. 27 Unions (or federations) and cooperatives in rice farming in Rwanda

FEDERATION OF RICE COOPERATIVES(FUCORIRWA)				
Name of Union	**District of Operation**	**Activity**	**Contact Person and Phone Number for the Union**	**Names of Farmers Cooperatives (members of the Union)**
UCORIBU (10 cooperatives)	Gisagara and Nyanza	Rice Cultivation		Cooproriz-Nyiramageni
				Cooproriz-Akanyaru
				Cooproriz-Cyili
				Cooproriz-Mirayi
				Cooproriz-Ngiryi
				Cooproriz-Agasasa
				Cooproriz-Nyarubogo
				Cooproriz-Gatare
				Cooproriz-Rusuri
				Cooproriz-Kabogobogo
UNION-TWIBUMBE (11 cooperatives)	Rwamagana and Ngoma	Rice Cultivation		COCURIBU
				COCURICYI
				COCURIGA
				COCURIGI
				COCURIMU
				COCURIRE
				COPERIG
				COPRIMWA
				CORICYA
				COCURIVAMU
				COCURIRU
UCOPRIBU-ABAHUJUMUGAMBI (10 cooperatives)	Bugesera	Rice Cultivation		CORINYABURIBA
				CORIVARWI
				INKINGI Y'UBUHINZI
				KOPAUKI-RUHUHA
				KOTERWA-MAREBA
				TWIZAMURE
				JYAMBERE

FEDERATION OF RICE COOPERATIVES(FUCORIRWA)				
Name of Union	**District of Operation**	**Activity**	**Contact Person and Phone Number for the Union**	**Names of Farmers Cooperatives (members of the Union)**
				NYARUGENGE
				KOPETWITEKI
				COGIRIRU
				CORIMARU
UCORIVAM (4 cooperatives)	Nyagatare	Rice Cultivation		COOPRIMU
				COOPRORIKA
				CORVANY
				CODERVAM
UCORIGI (4 cooperatives)	KIREHE	Rice Cultivation		COPRIKI-CYUNUZI
				ISABANE
				MRGC
				KIJUMBURA RGC
				CORIMU-KIREHE
UCORIHU (12 cooperatives)	HUYE	Rice Cultivation		CORITENYA
				COORIRWA
				CORIKIMWE
				CORISI
				CORIRU
				KOAU
				TWONGERUMUSARURO
				TUZAMURANE TUMBA
				UBUMWE TUMBA
				IMBEREHEZA MWARO
				CORIMAMU
				KOAIRWA
UCORIVABU (4 cooperatives)	RUSIZI	Rice Cultivation		KOJMU
				KOIMUNYA
				KEHMU
				COOPRORIKI
UCORINYA (4 cooperatives)	NYAMASHEKE	Rice Cultivation		ABISHYIZEHAMWE
				DUHUZIMBARAGA
				AIC KIBATI
				DUFATANYE KAGANO
CORIKA (Basic Cooperative)	GASABO	Rice Cultivation		
COPRORIZ-NTENDE (Basic Cooperative)	GATSIBO	Rice Cultivation		
CORIMI (Basic Cooperative)	NGOMA	Rice Cultivation		
Agriculture12CORIMAK (Basic Cooperative)	GATSIBO	Rice Cultivation		

- ***Processors and Traders-*** The total milling machine capacity in Rwanda is 17,355 MT/year. The capacity of each milling machine varies from 0.2 to 3.6 MT/hour. In 2009, only 10,321 MT paddy rice was processed by modern mills, while others were either milled illegally in small-scale hullers or hand pounded. Most of the cooperatives do not have accurate figures of the production; it is estimated that over 50% of paddy production is not marketed through the cooperatives. It is either consumed at the household level or sold directly to traders as paddy or milled rice. Generally, farmers would supply paddy rice to their cooperatives, which in turn sell to unions. The Union would then sell to the mills. In some cases, the cooperatives and unions are also shareholders in the mill. In the absence of a Union, the cooperative would sell directly to the mills. The mills would process and sell to intermediate traders, who buy bulk quantities of milled rice and sell it to retailers.
- ***NGOs and Civil Society-*** Local and international NGOs are not only funds providers but also service providers for local communities (agricultural inputs supply, marketing and processing of agricultural production, counselling, facilitation in problem and solutions identification, facilitation in farmers organizations in commodity chain, capacity building of farmers organizations, lobbying and plea for local communities etc.). NGOs and Civil society will have to provide feedback through stakeholders' platforms at different levels. Being service providers, they will have to sign contracts with public and private institutions funding in the agricultural sector.
- ***Private sector-*** The private sector is active in all steps of commodity chain starting from inputs supply, production, marketing, processing and commercialization of the processed or unprocessed product. Its role in decentralized agricultural extension will need to be reinforced for better ensuring the linkage between production and markets.
- ***Financial Institutions***- Despite its importance, the agricultural sector is not much financed by grants from commercial and development banks, comparatively with other economic sectors. That is why public sector funding is predominant in this sector through development projects, agricultural guarantee funds, Fertilizers Funds and other programs. This tendency will still be maintained for a specific time, but essential efforts will be deployed to encourage local microfinance institutions for more participation in financing the agricultural sector.
- ***Higher Agricultural Education Institutions***- Higher Agricultural Education Institutions play an indispensable role in the regular review of their curricula so that they train qualified staff responding to the profile of the new extension strategy, i.e. equipped with skills to work in rural areas, autonomously take initiatives, analyze complex situations of agricultural development, having competences in management and entrepreneurship, play advocacy & lobbying role whenever necessary. Higher Agricultural Education Institutions are part of stakeholders' platforms, at different levels. Moreover, the higher learning institutions participate in initiating and/or leading influential research projects from which great benefits are obtained by the government and the farmers, in different aspects of farming.

4.13 Gender aspects in the stakeholder landscape

MINAGRI has shown that about 52% of Rwandan farmers are women, playing a very significant role in agricultural production of Rwanda (MINAGRI, 2011). It has been noted that women in the age group of 15-60 years spend one-third of their time in agriculture, while men spend only 19% of their time in agriculture and 54% of their time in diverse leisure activities and on paid work, against 18% of women's time in this last category. As by 2001, rice growers comprised 20,208 women (45%) and 24,699 men (55%), although, women are not present in the processing and wholesale sub-sectors. They are predominantly represented in the retail sub-sector (60%).

4.14 Selected pilot: Gikonko rice growing scheme

The ScaleWAYS scoping study team identified Gikonko as pilot for rice intensification. Here we provide description of rice farming system including methods of rice growing, land preparation, seeds, labour/gender role, planting, weeding, harvesting, and marketing. Gikonko is one of the Southern Rice Production Schemes in Rwanda. Rice is grown here in two seasons i.e., Wet season (January-June) and Dry season (July-December). Most farmers are smallscale and each grows rice in less than 0.5ha which under irrigated Lowland yields an average of 4tonnes/ha. In this area farmer's associations exist which together form the Union of rice cooperative owner. The farmers own some 40% of Gikonko Rice Limited acquired through joint venture partnership with ICM owner of the remaining 60% of the factory). Farmers in this scheme have access to credit and farm in their own land and do not have to rent land from other farmers.

4.14.1 Popular Varieties and methods for rice cultivation

There are 3 popular rice varieties grown under irrigation in the scheme i.e., NERICA 12, IR 64, Yunyine, Zong geng andYun Keng. Land is prepared manually and after seedbed preparation rice seedlings are transplanted. In the scheme water for crop irrigation is supplied from a dam. Weeding hardly done using herbicide and chemical fertilizers are applied. At plant maturity harvesting and threshing are done manual. Women main activities in rice value chain are land preparation, sowing, transplanting, weeding, harvesting, threshing, winnowing, drying, transporting, storage. In the scheme the major challenges are poor water management, diseases, market for selling rice

4.14.2 Rice Marketing in the scheme

Rice marketing in Gikonko area is similar to that of the rest of the country. Rice produced in Rwanda is sold mainly in unorganized rural markets, whereas the mainstream urban markets mostly sell imported rice because the locally produced rice grains suffer higher breakages upon milling. Quality of Rice can be improved through adequate supervision and further privatization of milling operations. Besides, the quality can be enhanced by introducing technologies and raising the awareness on the handling of paddy grains at harvesting, drying, winnowing and storage phases by the producers.

After keeping some of the harvests for consumption, farmers sell the paddy grains in local markets. Farmers in some areas are obliged to sell their products to the cooperatives for getting continued assistance on the supply of inputs and other services from the cooperatives. However,

it takes time for the cooperatives to pay farmers and the prices are low which often force farmers to sell the paddy grains to unorganized rural traders and/or millers. There is a strong need to improve transparency through trading regulations and by facilitating predetermined contracts with millers/traders.

Most of the rice growers and other stakeholders along the rice value chain are constrained by the limited access to finance. Improved financing of rice farmers through diversified loan schemes and increased rural banking facilities and services that are targeted to farmers, cooperatives, agro-dealers, service providers and traders in marshlands will speed up the transfer of socio-economic benefits of growing rice.

4.14.3 Key implemented policy practices in rice growing

Some years ago, the Government of Rwanda decided to give high priority to the production of rice in the country's marshlands, where, with adequate investment in irrigation infrastructure, the crop is capable of yielding up to 7 t/ha during each of two growing seasons (MINAGRI, 2005). The government provided this investment and farmers responded by growing rice mainly as a cash crop. However, as production increased, there was a growing need to expand facilities for processing and marketing. At first, much of this processing was done with small hullers, which produced rice with substantial impurities and little uniformity of grain colour and size.

In addition to the hullers, the government earlier invested in several medium-sized mills of 1–3 t/hour capacity. By the time that the National Rice Program was going into effect, these mills were old and required substantial upgrading or replacement with more modern equipment. The government responded by privatizing these mills, turning them over to cooperatives or selling them to private investors. Often this was done as part of a joint venture arrangement between the cooperatives and the investors. The government sold 60% shares of these mills to private investors, and the remaining 40% shares were provided to rice cooperatives (among others UCORIBU Union des cooperatives de riz de Butare Gisagara Districts (of which the Gikonko rice farming scheme is part), in Southern Rwanda, Rwamagana and Bugarama) in the respective marshlands (Kathiresan, 2013).

The aim of promoting private and farmer's partnerships was to help farmers to better plan their production and marketing activities following market needs, as well as to participate effectively in the markets. Additionally, the joint venture was expected to give farmers an alternative marketing channel for their products and reduce costs by shortening the marketing chain (Kathiresan, 2013). However, according to ICM Rwanda Agribusiness, JV such Rwamagana and Bugarama was declared as non-performing with accumulated losses. The ICM claimed that in the past rice Unions like Twibumbe (Rwamagana) had failed to supply the quality and quantity of rice paddy agreed in pre-season farming agreements while the Gikonko joint venture had successful honoured the JV agreements and made a profit each year but, little study has been conducted to identify whether this profit has reached farmers. Thus, this study aims to explore whether the mentioned JV impacted or not farmers. The impact will be assessed in terms of improved access to market and farm income.

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5 United Republic of TANZANIA

5.1 Introduction

Agriculture continues to support the livelihoods of most Tanzanians, although it remains underdeveloped and generally vulnerable to the whims of nature. It is the mainstay of most of the households in the Southern Highlands where weather conditions are favourable for growing various food and cash crops. Paddy, maize, and sorghum are the most important cereal crops in this zone. Root and tuber crops like cassava, round and sweet potatoes, horticultural vegetables and fruits are also grown in some parts of the zone. Maize, beans, rice, potatoes are the main food crops while significant cash crops are coffee, tea (green leaves), pyrethrum, cardamom, sunflower, cocoa, tobacco, vegetables. As for rice, statistics indicate that approximately 24% of the national total production area is in the Southern Highlands and produce about 33% of the national rice produce (RLDC, 2009). Mbeya Region alone has about 135,215 ha under rice production, which is about 8.5% of the total national land under rice production (NSCA, 2006). Areas that are suitable for paddy production are the low altitude areas (below 350metres above sea level) of Usangu basin in Mbarali, Kamsamba in Momba and Msangano, Lake Rukwa Valley, shores of Lake Tanganyika (Kirando to Kasanga) and Lake Nyasa (Kyela and Mbamba bay). In many of these areas, average yields at small scale farmers' levels are low and range between 1.6 to 2.4 T/ha, although an average production of 5 to 6 T/ha has been recorded in irrigated schemes (Ngailo et al., 2011). Under optimum conditions potential yields of rice range from 4 to 6 t/ha for uplands and 6 to 10 t/ha for lowlands irrigated ecosystems of cultivation; however, this always depends on varieties of rice grown and management levels.

The significant factors contributing to the low yield include low soil fertility due to excessive nutrient mining coupled with little use of fertilizers, monocropping, poor agronomic practices, use of unimproved seeds, and poor access to output markets (Ngailo et al., 2013). Several global and national initiatives have been in place to emphasize the improvement of paddy production and therefore eradicate hunger and food insecurity. The Millennium Development Goals (MDG, 2000), which Tanzania also adopted were like in many other Third World countries were meant to address the question of low crop productivity amongst others. As a nation also Tanzania adopted the Kilimo Kwanza (Agriculture First), and Big Results Now (BRN, 2012) thrusts to put more emphasis on agricultural development and increased productivity of all crops, including rice. Such strategies have been successful in part because under such initiatives agricultural inputs at subsidized prices were made available to farmers who helped to curb the problem of inadequate availability of fertilizers and other inputs not only for the production of paddy but also for other crops such maize. Over the years the general problems causing low productivity of rice farming system in the SHT have been documented. However, specific information on the characteristic of the rice farming system and problems attributing to low productivity at the household level have not exhaustively been revealed. For that matter, this study was a prerequisite to adequately address the most common predicaments that hinder rice productivity at household levels in Mbarali and Kyela districts.

An estimated 2.2 million MT of rice is produced annually, making Tanzania the biggest rice-producing country in the region. The Government of Tanzania has long identified the rice sub-sector as a strategic priority for agricultural development due to its potential for improving food

security and income for large numbers of rural households with landholding sizes ranging from 0.5 to 3 ha. In Africa, the rate of increase in demand for rice is the fastest in the world because of population growth (4% per annum). The rising income levels and urbanization have led to shifts in consumer preferences in favour of rice over other crops. The consumption has been increasing by more than 34% since 2002 compared with 8% in Asia and 10% as the world average; with the continent accounting for more than 29% of global imports. In Eastern and Southern Africa (ESA), rice is considered both as a food and cash crop owing to its importance; however, the paddy productivity in ESA countries is below 2 tons per hectare.

There are plenty of opportunities for rice development to flourish in Tanzania due to abundant water resources for irrigation (groundwater, rivers, and lakes) and suitable land (21 million ha) for rice cultivation. There is a potential for an increase in national and regional demand for rice due to population growth, urbanization and increase in income. Seed production ventures and accredited seed certification systems (conventional and community based) exist to ensure that paddy farmers have access to quality seeds of improved rice varieties. The political will of the government, donor commitment and suitable policy environment (e.g. exemption of taxes and subsidy on agricultural inputs) do also favour rice production in the country.

5.2 Global, Regional and National Trends of Rice Production and Consumption

Rice is produced in over a hundred countries throughout the World. It is estimated that more than 715 million tons of paddy are produced annually equivalent to 480 million tons of milled rice. Asian countries account for 90% of the world's total rice production. China and India account for 50% of the rice produced in the World. Other major producing countries include Brazil, the USA, Egypt, Nigeria, and Madagascar account for 5 % of rice produced globally. Global rice consumption has been increasing in the 2018/2019 crop-year, about 490.27 MT of rice was consumed worldwide, up from 437.18 million MT in the 2008/2009 crop year.

Rice has emerged as a significant crop in SSA, the most critical source of dietary energy in West Africa, and the third most crucial crop across SSA. Local demand is growing at a rate exceeding 6% per year, with some countries like Kenya and Ethiopia reaching over 12%, faster than any other food staple in the region. This increase is mostly attributed to a population growth of 4%, improved income, and urbanization. Average annual per capita rice consumption is estimated at 40 kg in SSA, with the highest reported in Madagascar 140 kilograms. In Tanzania, the per capita consumption of rice is estimated to be 25 kg.

Reasonable production gains were witnessed in the last decade, attributed to both area expansion and increase in yield in some countries. However, the gap between local/regional production and demand is progressively widening, causing the region to import about 15 million tons of milled rice in 2018, and posing severe food security challenges. Rice is now recognized as a strategic crop and a significant component of food security and income for the region.

Regional rice production meets only about 55% of demand, with the rest being met through imports, costing the region USD 5–6 billion annually, placing a considerable burden on the already struggling economies. In Tanzania, rain-fed areas, which constitute over 70% of rice areas, are not sufficiently exploited, and the country has plans to expand its irrigated areas. The

regional gap in demand for rice could significantly be narrowed with the most abundant untapped land and water resources and the enormous potential for increasing yields in Tanzania to at least match that being attained in Asia. In the long run, Tanzania can potentially produce sufficient quality rice to meet the SSA/regional demands, and with potential for export to the whole continent.

5.3 National and Regional Trends of Rice Production and Consumption

About 71, 9 and 20 % of rice cultivation in Tanzania take place under rainfed lowland, lowland irrigated and upland conditions, respectively. Available information indicates that more than 70 % of rice production in the country originates from six leading rice-producing regions: Shinyanga, Tabora, Mwanza, Mbeya, Rukwa and Morogoro. Other areas include Songwe, Katavi, Arusha, Kilimanjaro, Kigoma, Manyara, Iringa, Mara and Tanga. Over the past two decades from 1995 to 2014, the area under rice and production at the national level increased by 57 and 76 %, respectively. Increase in production has gradually reduced the need for imports, and rice self-sufficiency has been attained in recent years (Table 5.1).

Average paddy yields across ecosystems have varied widely during the same period (between 1.25 and 2.5 tons per hectare) without a clear increasing or declining trend (http://ricepedia.org/tanzania). Average paddy yields also significantly vary among the rice-growing regions. For example, the average paddy yields in 2016/17 cropping season for Morogoro and Mbeya (the two major growing regions) were 4.0 and 2.2 t/ ha respectively (NBS, 2018). Around 90% of Tanzania's rice production takes place under smallholder (small-scale) system. The sizes of rice farms range from 0.5 to 3 ha, with an average farm size of 1.3 ha (MAFC, 2015). Among the cereal crops, rice alongside maize has been selected as one of the strategic commodities for government investment in both Agricultural Sector Development Programs ASDP I (2006/07-2012/13) and ASDP II (2017/18–2027/28). The criteria used to select the priority commodities were contributions to the value of agricultural production, national food security and food import bill and export revenues.

Table 5. 1 Trend of Rice Production and Consumption

Year	Area Harvested (Ha)	Yield (t/ha)	Production (MT)	Requirement (MT)	Self-sufficiency ratio (%)
2011/2012	900,275	1.3	1,170,358	818,699	143
2012/201	1,005,622	1.3	1,307,308	840,487	156
2013/2014	840,563	2.0	1,681,125	886,962	190
2014/2015	1,139,358	1.7	1,936,909	926,096	209
2015/2016	1,238,372	1.8	2,229,071	976,925	228
2016/2017	758,861	2.1	1,593,609	924,435	172
2017/2018	1,109,814	2.0	2,219,628	990,044	224

Source: MOA reports-Tanzania

5.4 Rice Production and value chain in Tanzania

FAO conducted the rice value chain analysis between July and August 2012 and results show that although there is a wealth of information in this area, there is such disparity between quantitative data sources which throws much doubt on their reliability and usefulness creating an open to doubt. Thus, such much information on the rice value chain is considered as merely indicative rather than definitive. There are inconsistencies in official data, especially on production, export and import information. However, it is worth knowing that rice is the third most important food crop in Tanzania after maize and cassava. Official data indicate that current total production averages about 1.35 million tonnes. Rice is grown in most regions of the country: with the Coast, Morogoro, Tabora, Mbeya, Mwanza, Shinyanga and Arusha Regions each producing more than 100 000 tonnes. Almost 20% of farmers in the country are involved in rice production, and small-scale farmers are the leading rice growers. The crop is typically grown under rainfed conditions, but some small farmers grow and irrigate 2-2.5 hectares under schemes that are often initiated and controlled by the government.

Large scale commercial rice growing is done under irrigation which is limited to only a few private firms who own the former National Agricultural and Food Corporation (NAFCO) schemes which were privatized. In recent years the Tanzanian government, private sector and civil society have demonstrated a sustained commitment to realizing Tanzania's agricultural potential. The Agricultural Sector Development Programme (ASDP) 2006—2015 of the Government of Tanzania is part of the broader National Strategy for Growth and Poverty Reduction (commonly known by its Kiswahili acronym 'MKUKUTA'). The government-endorsed a private sector initiative to invigorate agriculture through the 'Kilimo Kwanza' ('Agriculture First') campaign in 2009. The Government has prioritized rice through its National Rice Development Strategy which sought to improve food security and provide a potential surplus for export by doubling rice production by 2018. In this strategy the government aims at improving seed cultivars and input supply, the availability of irrigation, marketing, Research and Development (R&D), and agricultural credit where the significant programmes and policies include providing fertilizer and seed subsidy, and seed R&D; infrastructure development (including irrigation and roads); an import tax of 75 % on milled rice for mainland Tanzania; and the removal of the export ban during 2012.

Active markets for paddy and rice throughout the year exist in Tanzania. Rice is mostly sold to consumers as polished milled rice, and many consumers prefer the aromatic long-grain rice, but the sticky white long grain rice is also in high demand. Rice is a staple food and is consumed in both urban (60% of national consumption) and rural areas in the country. The rural consumers such as smallholder rice farmers usually retain about 370 kg of their production for domestic use. It is worth noting that consumers in Tanzania mostly demand for 20 % broken rice and therefore processors usually mix broken and unbroken rice to achieve this demand.

Similarly, they mix non-aromatic with aromatic rice as there is little demand for the former. Tanzanian rice is preferred over those imported, but there are also differences in regional preferences, and rice is often labelled as being from regions. For instance, many consumers consider rice from Kyela as the best, followed by rice from Mbeya and then from Morogoro while Shinyanga rice is viewed as low quality in Tanzania. There are local and foreign-owned supermarkets as well as foodservice market, hotels and education instructions which provide an

essential end-user of rice markets in the country. Some aroma studies have shown that in Tanzania rice is the most commercialized (42%) compared to other staple crops such as maize (28% and sorghum (18%) (National Sample Census of Agriculture (NSCA) 2002—2003). It was also observed that rice prices in Dar es Salaam have been higher than world prices except for during the year 2008 suggesting that Tanzanian consumers may be paying a higher price for rice compared to others outside the country. However, it is worth noting that Tanzania regularly imports rice, primarily because the domestic wholesale price in all markets is significantly higher than other international rates. The lowest local prices are in Songea (which is a rice surplus zone), followed by Singida (which is near the production zones of Mwanza and Shinyanga) while the highest prices are in Dar es Salaam and other rice deficient markets.

There are seasonal variations in rice prices which justifies the need for providing excellent storage facilities to help stabilize prices and ensure reasonable prices for producers. Rice prices are lowest immediately after harvest when supply is high. Rice exports from Tanzania mainly to neighbouring countries including Uganda, Rwanda, Kenya, and Burundi and sometimes to Malawi and Zambia accounted for only about 5% of rice production during the 2000s. There is also a considerable amount of informal trade, i.e. via illegal or 'Panya' tracks, especially in main producing areas near borders. Table 5.2 shows the estimates for rice exported to neighbouring countries in 2011.

Table 5. 2 Estimates of Tanzania milled rice exports (tonnes) to neighbouring countries, 2011

Country	**Amount exported (tonnes)**			**Total exports**
	Tanzania data	**Formal trade**	**Informal trade**	
		Importing country data		
Uganda	7 743	27 338	2 734	30 072
Rwanda	23 985	24 228	2 423	26 651
Kenya	2 622	10 475	1 048	11 523
Burundi	155	5 877	588	6 465
DRC Congo	1 409	1 409	141	1 550
Total	35 914	69 327	6 933	76 260

Source: Stryker and Amin, 2012. Based on data collected by FEWS NET, RATIN and the Eastern Africa Grain Council

Long-term projections for the East African region are for a substantial and growing deficit in food. The rice deficit is expected to rise from 1.15 million tonnes in 2009 to 2.84 million tonnes in 2020, with a rising trend forecast to continue until beyond 2025. A critical factor in terms of exports, however, is the rate of rice production growth in Tanzania. Production in the decade from 2001 to 2011 grew at 6.99 % per annum (see previously) but, because of a rapidly growing domestic demand, Tanzania will find it difficult to achieve and sustain an export surplus. If the rice sector were to make a 10 % annual growth rate, there would be surplus available for export; a 5 % yearly growth rate would, conversely, result in increasing trade deficits.

The value chain describes the range of activities required to move a commodity from the first point of production to the last location of consumption. The chain usually involves (an often complex) combination of physical changes, inputs from various producer services, transfers of ownership and deliveries. Commodity value chains are increasingly recognized as providing a robust framework for the analysis of the public and private sector stakeholders within them, as well as the overall performance of markets. The rice value chain is confounded by many technical and institutional impediments (from supply and use of inputs, via production and processing to marketing and retailing). The chain is fragmented, uncoordinated, disorganized, and uncontrolled (despite being over-regulated). It is dominated by large numbers of small-scale producers, an unknown (but undoubtedly immense) number of intermediaries who operate across every link, and a similarly unknown number of small processors and individual sellers who supply restaurants, cafes and street vendors (or otherwise put products on the market for the consumer), but who mainly lack the technical and financial ability to run it efficiently and profitably.

The horizontal and vertical linkages of the value chain are generally weak and uncompetitive and will need support if they are to strengthen. In Tanzania, there are multiple horizontal and vertical links from the producer to the consumer. The rice chain involves and includes primary producers, traders in paddy and milled rice, processors, wholesalers, retailers, and consumers. Most actors are not specialized, and their functions relate to various segments of the value chain.

5.5 The value chain map

A preliminary evaluation of the value chain shows that the whole is suspended from the consumer. If the link to the rest of the chain were to be broken, the whole would be susceptible to collapse. This situation is real for all other links in the chain. Each link takes the product from its immediate predecessor and 'processes' it to an output that is used by the next link. Nominally, the value of the product increases at each stage until it reaches the consumer. It is possible to provide a brief list of most of the participants in the chain (see Table 5.3), but pivotal roles are played by the middle links of the chain through which all products must pass. Many participants in the chain (see Table 5.4) occupy more than one role.

Further up the chain, some processors are also wholesalers and retailers, operating in both the domestic and export markets. Primary producers may sell rice in three keyways: directly through a market, to a trader, or to a processor (they may also use a combination of outlets). A trader may similarly sell to another trader, or directly to a wholesaler, retailer, or processor (or again, may broaden his options by using a combination of all channels). Processors, especially the smaller enterprises, may buy rice directly from farmers or traders, and sell the products to wholesalers or retailers. Every link in the value chain relies on goods and services to fulfil its role(s). At various stages, goods and services include land, labour, machinery, seed supplies, fertilizers, pesticides, transport, energy, and finance. Also required are clearly defined and enunciated standards and a regulatory framework under — and applied by — law. Many of these requirements continue to be weak or nonexistent in Tanzania.

Table 5. 3 Simple listing of supply and service participants in the Rice Value Chain

Core Actors	Service suppliers
Producers: traditional primary producers (who rainfed); improved smallholder production (who use inputs and limited irrigation); commercial producers (who use irrigation and include partly integrated enterprises and a few out growers)	1. Research 2. Training and Education Institutions 3. Extension service 4. Inputs (seeds, fertilizers, agrochemicals) 5. Transport 6. Financial services 7. Associations (producer, trader, processor, Tanzania Edible Oil Seeds Association) 8. NGOs and International Aid Agencies International Rice Research Institute (IRRI)
Traders and agents	
Wholesalers	
Dry rice retailers (rural, urban, supermarkets)	
Rice product retailers (street vendors, cafes, shops, supermarkets)	
Importers	

Table 5. 4 Participants and functions in the Southern Highlands Rice Value Chain

Participants	**Functions**
Research & extension	There is considerable research on rice in Tanzania. The International Rice Research Institute has a significant presence, as do the Consultative Group on International Agricultural Research (CGIAR, see Annex 5). The Zonal Research Institutes and other stations of the Ministry of Agriculture, Food Security and Cooperatives (MAFC) research rice but need reliable long-term core funding. Uyole Agricultural Research Institute in Mbeya has responsibilities in training and extension. The Iringa Veterinary Investigation Centre is the reference laboratory for diseases in the Southern Highlands. Research, in principle, works hand in hand with extension.
Input suppliers	MAFC and the municipalities provide limited extension services. The Agricultural Research Institutes (ARI) and Agricultural Seed Agency (ASA) have developed many new varieties, and the International Rice Research Institute (IRRI) has released two new types bred primarily for Tanzania. However, demand for and uptake of these is very low. None of the 15 private seed companies in Tanzania distributes improved rice seeds. The Government subsidizes fertilizers via a voucher scheme, but this benefits large farmers more than smallholders. Financial services are limited and available only to a favoured few.
Producers	Most rice (74% by area) is upland rice grown by smallholders. Next in production magnitude (20%) is the improved small-scale rainfed production (with some limited irrigation). Finally (6 %) is from the large-scale production and trading companies that may be partially vertically integrated (and to a lesser extent horizontally throughout-growers)
Traders	Primary buyers and secondary buyer-agents operate throughout the country. Much trading takes place at the point of production. There are a multitude of middle- and small-sized traders throughout the country as well as some larger ones. There is some trade by road from surplus to deficit areas, but the leading long-distance trade is towards the Dar es Salaam market.
Processors	Initial processing — threshing out the paddy, drying and storing — takes place mainly at the point of production usually under intensive labour and often primitive conditions. Post-harvest losses are incredibly high with as much as 50 % of the original grain being lost for various reasons. Local traders and millers further along the chain add value through milling the paddy. Milling is the

	central hub of processing when the hull (husk) is removed from the grain to become 'rice'. Most mills have a capacity of 5 to 20 tonnes of paddy per day, and these probably account for more than 90 % of milling operations. The larger millers — up to 120 tonnes per day — generally operate for about five months in each year. Small mills typically produce inferior rice of 'standard' quality (30—50 % broken) whereas larger mills produce 'Grade One' rice with less than 15 % broken grains.
Retailers	Retailing of raw milled rice ('mchele') is usually done through local shops or 'maduka' by recognized but often informal businesses. Street traders and cafes sell cooked rice 'wall' in various ways almost always accompanied by a vegetable or meat sauce. Better quality rice is available at most supermarkets and some specialized retail shops.

5.6 Rice Production Systems in Tanzania

In Tanzania, there exist three major rice production systems namely the Traditional Production System, Improved small-scale rainfed production with some limited irrigation and Large-scale production system.

5.6.1 Traditional Production System

Traditional Production System (either lowland flood or upland dry) is the predominant system and contributes about 74% of the national rice area. Small-scale farmers with minimal improved technology dominate it. Most farmers plant own saved seeds, with minimal fertilizer use, limited use of WRS for storage, and spot prices are the norm in local markets. In this system, the rice value chain is long and fragmented both horizontally and vertically. Paddy is bought by local or regional traders who process it with small local mills while some are purchased directly by small mill-owners, who in turn sell milled rice to traders and rural households. Brokers also buy milled rice from millers and sell to straight to urban wholesalers (who in turn sell to urban retailers). Limited value addition is done at the milling stage since most small mills produce poor quality rice and broken grains, which fetch low price where milled rice is sold at market. Over 30% of rice is consumed locally and does not pose any threat to the local market. Small quantities from the traditional system are exported to neighbouring countries.

5.6.2 Improved small-scale rainfed productions system with some limited irrigation

This constitutes some 20% of the nation's rice areas, and improved production systems are used, e.g. some new cultivars, plant (by hand) in rows, use some fertilizer and gives better yields. There exist coordinated and bulk trading, via a WRS, which allow better management of the price risk because market access is controlled, and the post-harvest losses caused by poor storage are minimized. Paddy is usually custom milled in small mills near production areas. Farmers, at times, operate in groups and take on additional value chain functions which provide incremental improvements in both horizontal and vertical integration at the local level.

5.6.3 Large-scale production system

The system is done in 6% of the nation's rice areas and involves large-scale commercial farms and trading companies who also get rice from out-growers. The operators are engaged in other chain functions which also include the supply of farm inputs and services including storage, mill, and sale to urban wholesalers. Some large producers also have their mills or contract a medium to a large mill to process their paddy. These producers can transform the value chain primarily through improved integration and chain efficiency, performance, governance, and information flow.

5.6.4 Rice production activities in Tanzania

Since most of Tanzania's rice is still grown under rainfed conditions, the yields vary and prices are uncertain and fluctuate by seasons at the farm and national levels which may discourage farmers from investing and use of improved farming systems needed to ensure good yields and better income to farmers. According to USAID (2010), critical uncertainty and risk in the rice value chain are common in production, processing, marketing, storage, financing and transportation processes and the case of Tanzania is no exception. In a recent study in Mbarali and Kyela districts, Uyole et al., 2016, reported that rice is one of the principal crops produced in some 20,453 ha with a good potential of increasing each year. In these districts the rice farming system is diverse and that while traditionally farmers have grown local crop varieties in their fields which are low yielding (< 2 $MTha^{-1}$) use of improved farming methods such as better seed varieties which yield over 7 $MTha^{-1}$ under optimum show high potential for increased production and interests in rice-growing (Mussei *et al*., 2013). Currently, the Tanzania government and other development partners train farmers on the use of improved rice varieties and other desirable properties to ensure adoption and get good yields. Further researchers have reported that some local varieties have good qualities such as taste and aroma, but which can be incorporated in the breeding programs to improve rice productivity.

It is also observed that farmers in the area prefer using some improved technologies, e.g. using oxen plough for land preparation has now changed to using motorized farming equipment such as power tillers and tractors for land preparation. Use of mechanized harvesting (use of medium-scale combine harvesters) is also gaining popularity in the districts.

Although many farmers are aware of the importance of input use, the main problem was their availability, the right type and time for application in the fields and correct rate of application as required by rice crop. Nevertheless, the majority (>84%) of farmers efficiently used topdressing fertilizers such as urea (46%N) compared to basal fertilizers such as DAP, MRP or TSP. The study also showed that although organic fertilizers are essential for rice production farmers do not use them in their rice fields. The use of modern ways of soil and water management to improve rice of productivity in the two districts is high where upland rice cultivation is common. Further, the studies show that most farmers (84%) used herbicides to control weeds and (54.4%) now use inorganic fertilizers in rice production. The number of farmers still planting rice by broadcasting is declining in favour of line transplanting seedlings in the districts and indeed in many rice-growing areas in the country.

It was also found that although many farmers still operate individually, some belong to savings and credit services; mainly through their savings and credit cooperative society (SACCOs). In these two districts, large herds of livestock graze on rice straws and husks left in the field after harvesting and threshing. In some cases, the leftovers are burnt within the fields, leaving most of the nutrients, especially nitrogen embedded within the residues to be wasted. If crop stover is utilized well soil nutrient improvement will easily be improved to a greater extent.

5.6.5 Challenges in rice production

Now the rice sector lacks integration, transparency, regulation enforcement and a conducive business environment. Small producers are particularly disadvantaged because of their distance geographically and physically from the main consumer markets and lack of information on market prices while the primary factors driving the dynamics in the value chain include:

i. Government trade, market, transport, land tenure and irrigation policies.
ii. Weather (climate) and its effects on production
iii. Consumer income and related preferences
iv. Investment decisions by large producers, traders and millers in production, storage and processing
v. Competition from other crops

Table 5.5 shows production constraints as ranked in order of importance reported by the farmers from in districts. These included unreliable rainfall (29.5%), disease/pests (25.6%), high price of agro-inputs (23.3%) and inadequate capital (21.1%).

Table 5. 5 Major constraints in Rice production

%age constraints	**Mbarali (n=120)**	**Kyela (n=120)**	**Overall (n-240)**	**(N)-Ranking**
High weeding costs	6.1	31	18.5	
Low yields	18.4	18	18.5	
Unreliable rains	28.9	30.140.7	29.5	1
Diseases/pests	10.5	40.7	25.6	2
High input prices	28.1	18.6	23.3	3
Inadequate capital	26.3	15.9	21.1	4
Lack of farm implements	7.9	16.8	12.3	
Inadequate water from schemes	36	0	18.1.	
Floods	11.4	9.7	10.6	
Droughts	2.6	23.7	13.2	
Poor soil fertility	8.8	0	4.4	
Poor extension services	8.8	0	4.4	
Poor access to improved seed	10.5	1.8	6.4	

Note: N= number of respondents. A survey carried by Ngailo et al. (2013) also found out that farmers do not apply enough fertilizers in the farming system culminating in a reduced crop.

5.6.6 Rice marketing challenges

In many rice farming areas, the crop is grown under rainfall conditions such as in Kyela and Mbarali districts and in case of declined rainfall rice yields will also decrease or even complete loss. However, in areas with irrigation, the water shortage problem is lessened crop failure is not an issue. The common rice diseases reported by farmers include hopper transmitted rice yellow mortal virus (RYMV), which can cause significant yield loss in large areas of the rice crop. Shao-Mwalyego *et a*l. (2011) proposed measures to minimize the problem even as the disease is still persistent in several rice farming areas in these districts. In many rice-growing areas, marketing is a major production constraint in the rice value chain. The main rice marketing constraints are shown in Table 5.6. Attempts to have organized markets that can dictate the price of the rice commodity had met stiff resistance from private buyers, intermediaries and brokers. But efforts are in progress to sensitize farmers to join up together and strengthen their bargaining power. Various projects such as the Alliance for Green Revolution in Africa (AGRA) are training farmers on how to sell their rice crop when they are together profitably. The government of Tanzania is also finding solutions to rice marketing by purchasing some products through the National Food Reserve Agency (NFRA). Many of such marketing problems depend on the willingness of policymakers to assist farmers.

Table 5. 6 Main marketing constraints in rice production

Constraints (%)	Mbarali (n=120)	Kyela (n=120)	Overall (n-240)
Unreliable market	42.4	42.2	42.4
Fake measurements	32.6	15.2	23.9
Low rice price	39.1	63	51.1
Farmers are price takers	14.1	8.7	11.4
Poor infrastructure	20.7	4.3	12.5

Note: N= number of respondents

5.7 Selected pilot: Mara Region (Rorya, Bariadi, and Bunda districts)

5.7.1 Production status and development plans/ ambitions for rice

There are various forms of rice production systems depending on the districts which are either large scale and or small-scale. There are also open market farming system and contract farming, which also depend on the type of water system. Most rice in the region is grown under rainfed production system, irrigated production system and/or supplemental irrigation production system. Our field studies found that water is hardly a limiting factor for rice production in the selected districts throughout the year. Therefore, there is great potential for increasing rice production provided significant challenges on availability and access to quality seed and inputs can be addressed. The ability and willingness to use improved seed variety; quality pesticides; and improved livestock breed is high. Farmers who are members of rice schemes have the capacity in terms of infrastructure for value addition—rice mills; warehouses; and financial literacy. There is a stable working relationship between rice scheme leaders and local government officials at all levels. The scheme members are governed by a well-stipulated set of laws and procedures (constitution). The schemes have different sources of revenue streams

which includes membership fees, leasing fees, penalties, fines, subsidies from the government, investments (rice milling machines and warehouses). The rice schemes have different committees tasked with various responsibilities—disciplinary; water management and usage; finance and planning; production and marketing; technical advisory and communication. At some points there exists political interference from political leaders—especially on water use and management. Rice/paddy production areas are given in Table 5.7 and the Crops grown in cohort or neighbourhood with rice and their relative roles in Table 5.8

Table 5. 7 Rice/paddy production areas within the study area

Region	District
Mara	Rorya
	Bunda
Simiyu	Bariadi DC
	Busega

Table 5. 8 Crops grown in cohort or neighbourhood with rice and their relative roles.

Crop	Cohort/ Neighborhood	Relative roles
Sorghum	Neighbourhood	• Mainly for food • Animal feed
Cassava	Neighbourhood	• Food • Business • Local brew
Maize	Neighbourhood	• Food • Business • Animal feed • Local Brew • Organic matter for soil fertility
Cotton	Neighbourhood	• Business
Coffee	Neighbourhood	• Business • Beverage
Sesame	Neighbourhood	• Food • Business
Legumes	Neighbourhood	• Food • Business • Soil fertility • Animal feed
Cashew	Neighbourhood	• Business • Food
Sisal	Neighbourhood	• Business • Building materials
Horticultural crops	Neighbourhood	• Business • Food • Animal feed

5.7.2 The place of Rice intensification system in Mara Region

Rice remains the second most cultivated food and commercial crop in Tanzania after maize, with a cultivated area of about 681,000 ha, representing 18% of the cultivated land but yields are generally very low (1-1.5 tons/ha.) since most farmers (71%) use with traditional methods under rainfed conditions. About half of the country's rice is grown by 230,000 smallholder farmers in the Tabora, Shinyanga and Morogoro regions of the Central Corridor. It is worth noting that although Tanzania meets 98% of its rice demand, rice productivity in the country is low due to the impacts of climate change, inadequate use of improved technologies, low levels of involvement of the private sector in the rice value chain, poor irrigation infrastructure, limited participation of youth in agriculture and limited knowledge among small-scale farmers on implementing good agricultural practices.

Rice production in Tanzania is practised in both lowland and upland areas with 29.4 million hectares having potential for irrigated rice bit only 461,326 hectares of this land under rice crop. With support from the Government of Venezuela, FAO implemented the Partnership for Sustainable Rice System Development in Africa project, which is promoting the System of Rice Intensification (SRI) as a means of addressing current constraints the area under the crop has been on the increase lately. The Government of Tanzania plans to increase rice production and become a significant net exporter of rice for the region and Africa given the vast amounts of suitable, unfarmed, arable land, a high rate of self-sufficiency and current low yields.

The System Rice Intensification (SRI) was introduced to Tanzania in 2009 by Kilombero Plantations Limited (KPL) to increase the country's food security and became a common practice by 2013 in regions such as Mkindo and Dakawa in Morogoro as well as in Mwanza and Kilimanjaro Regions. Currently, some 5000 ha and 215 ha are under rainfed and irrigated rice in Tanzania, respectively. This gives an annual rice production of 33,000 tons of milled rice and 5,000 tons of other rotation crops (beans and pulses.) when employing the SRI methods. With improved Irrigation Infrastructure Crop Production in the Mbeya, the region has increased the area of irrigated land from 49,117 hectares in 2018 to 71,890 hectares in 2019 through an initiative by the Tanzanian government through the National Irrigation Commission (NIRC). According to Taribo as cited Madibira scheme, one example whereby through SRI production has increased to 9.3 tonnes per hectare, from 7.2 tonnes per hectare (traditional farming) "the new system of rice farming doubles rice production per acre." With the technical assistance from FAO, the project has provided better livelihoods for 2,600 rice growers in areas where the project was implemented.

According to Fred Kafeero, FAO representative in Tanzania the project contributed to the implementation of the National Strategy for Involvement of Youth in Agriculture of 2016. The project addressed challenges causing low rice productivity in Tanzania through the adoption and upscaling of the System of Rice Intensification (SRI) using proven approaches that FAO has tested in many countries. The project has currently more than 600 youth and 2000 adult farmers trained and are scaling up the rice production method in project areas and beyond and earn a good living. This has led to the government launching the Expanding Rice Production Project (ERPP) in 2015 to boost rice production, increase food security and strengthen the country's agricultural sector. The project was featured recently in an article in *Borgen Magazine*.

The ERPP commenced in Morogoro, Tanzania's mainland, and Zanzibar, in partnership with the Global Agriculture Food and Security Program. The Expanding Rice Production Project has made an impact on food security by quickly and effectively increasing rice production in Tanzania. More than 13,000 people had benefited from the program as of December of 2017, with rice farmers tripling production. The ERPP is expected to help 165,345 people by the end of the program in late April 2020. Several reports, theses and journal publications from Tanzanian Universities and other stakeholders have reported the SRI practices and benefits. An additional six theses (three from Sokoine University of Agriculture and two from Ohio State University) were also completed. New videos have also been produced on SRI in Morogoro region where the success of SRI has led to an increase in the national economy, created employment and increased income for many farming households. During this study, it was found that many publications and scientific report on rice production through SRI exist (see list provided below).

5.8 Policies, Institutional framework and strategies for rice production

5.8.1 Status of the Sector in National Policies

Tanzania's commitment to addressing the food and nutrition security issues is well reflected in the Long Term Perspective Plan (LTPP), National Five Year Development Plan (FYDP) 2016/17-2021/2022, National Agriculture Policy 2013 (NAP 2013), Tanzania Agriculture, Food Security Investment Plan (TAFSIP), Agricultural Sector Development Programme Phase Two (ASDP II 2017/18-2027/2028). These national and sectoral development frameworks envisage the agriculture sector growth of up to 7.6 % by the year 2020. Thus, the Government's commitment is to bring about the green revolution that entails the transformation of agriculture from subsistence farming towards commercialization and modernization through crop intensification, diversification, technological advancement, and infrastructural development. Policies plans and strategies of the government are centred on prominently transforming challenges in the agriculture sector that focuses on increasingly market-based agricultural systems that consider current and future demand trends for food, raw materials, and labour. The transformation requires integrated and collective actions to read institutions capacity and policies as well as technical know-how involved in the production and marketing of agricultural produce.

In response to these trends, the government of Tanzania is implementing Sustainable Development Goals (SDGs) globally agreed targets of addressing poverty, hunger, employment, and economic growth by the year 2030. Similarly, the Government is committed to implementing the African Union's (AU) Comprehensive Africa Agriculture Development Programme (CAADP). CAADP pillars are centred in extending the area under sustainable land management, increasing food supply, reducing hunger, improving rural infrastructure, agriculture, research, and technology dissemination.

Currently, the Ministry of Agriculture, in collaboration with Agricultural Sector Lead Ministries (ASLMs) is implementing the Agricultural Sector Development Programme Phase Two (ASDPII). The implementation of the programme responds to the National Agriculture Policy (NAP 2013) and the Agricultural Sector Development Strategy (ASDS). The target is to create

enabling and conducive environment for improving productivity and profitability of the agricultural sector as the basis for ensuring household income, food and nutrition security, and rural poverty reduction. Also, to provide opportunities for upscaling, increasing profits and creating jobs to value chain actors through the expansion of forward and backward linkages in the economy.

Thus, the focus of ASDP II entails transforming subsistence smallholder into sustainable commercial farmers by enhancing and activating sector drivers through increasing productivity of targeted commodities, including rice. This will be achieved through the implementation of the four major components that support sustainable water and land use, enhanced agricultural productivity and profitability, commercialization and value addition and sectoral linkage and coordination. Therefore, National Rice Development Strategy phase II (NRDS II) is in line with both national policies and international commitments that Tanzania has ratified aimed at improving the livelihood of the majority of rural communities through enhancing household incomes from paddy farming, food and nutrition security.

According to our studies, the agriculture policy is generally supportive of agriculture development initiatives at the sector level in terms of financing, skills, and technology. However, there is a gap in terms of policy implementation at the district level. The Local Government Authority (LGA) is inclined more to the collection of revenues than implementing the policy. Moreover, the LGA employees report to a different ministry, e.g. the President's Office Regional- Administrative and Local Government (PO-RALG) while the policy is made by, hosted under, and supervised by the Ministry of Agriculture (MoA). There are provisions in the policy related to agriculture development project financing such as 5% of total revenue collection should support the agriculture sector development initiatives, but this has been more of lip service in the past.

There is also a structural challenge in terms of reporting line. The District Executive Director (DED) reports to PO-RALG; while the heads of departments for agriculture and livestock report to DED presenting a very long loop of reporting via PO-RALG to the MoA hence affecting the implementation of the agriculture policy initiatives at the district level. We also find that there is a skills gap at the district level, which impedes the implementation of agriculture and livestock development projects. Most of the implemented projects at the district level involve various stakeholders from both the private and public sectors.

In summary, we find that the following policies favour/promote agriculture/rice production in Mara region, Tanzania:

- ✓ The agriculture policy of 2013 with its revised version of 2019
- ✓ National Rice Development Strategy Phase II (NRDS II), 2019-2030
- ✓ Some aspects of the trade policy 2013 especially those that restrict selling staple food commodities in the form wanted by buyers and regarding the use of staple food commodities implemented by regional and district authorities.

5.8.2 Consumer Preferences and Demand Projection

Rice consumers in Tanzania are very keen on the grain size, colour, flavour, and aroma. Majority of the consumers prefer long slender, translucent, intermediate amylose content and aromatic to semi-aromatic. The two popularly preferred Tanzania rice in domestic and regional markets includes Supa and TXD 306 (SARO 5). The common grades of rice available in the local markets are premium, grade one and standard. Premium prices are usually given to aromatic rice type, e.g. Kyela brand and other rice brands of premium or grade one when sold in an attractive package. The demand projection for rice is envisaged to increase because of urbanization, change in consumption pattern, increased in diversified use of rice-based products and economic growth. Current national rice consumption is estimated at 1.8 MT and is projected to reach 2.6 MT by 2025 and 3.5 MT by 2030.

5.8.3 Typology and Number of Rice Farmers, Processors and Traders

Majority of rice farmers (females, males, and youth) are smallholders who produce rice for home consumption and sell the surplus directly to traders. Also, other forms of marketing, like contract and auction, can be used through the Warehouse Receipt System and Tanzania Mercantile Exchange (TMX) when fully operational. Although most of the farmers do cultivate over a farm size that ranges from 0.5 to 3 hectares, there are large scale commercial farms such as Kilombero Plantation Limited-KPL in Morogoro region and Kapunga Rice Plantation Project, Mbarali Rice Farm and Madibira Rice Farm in Mbeya region.

Processors (millers) are in most of the production areas and range from medium to large scale ones. Medium-scale processors are in urban centres near production areas and owned by male and female entrepreneurs. Some processing machines can produce white stone-free rice of premium (unbroken), standards (half-broken) and regular (three quarters broken) grades. Large scale processors include Kapunga and Mbarali rice farms in Mbeya region, KPL in Morogoro and Madibira rice farm in Mbeya region. These processors process their farm produce and paddy from other farmers in the vicinity.

Traders in paddy and milled rice are scattered throughout the country. Both females and males are involved in this trade. Paddy trade is concentrated in production areas, while trade in milled rice is usually at wholesale and retail levels in production and distant markets. Price for milled rice is relatively higher than that of paddy of same quantity irrespective of the wholesale or retail market. Physical mixing of aromatic and non-aromatic rice is often practised by some traders to get a good price. Rice sold at retail shops, and open markets are usually put into jute bags. The export trade of milled rice is commonly through sell to neighboring countries. Produce cess charged by District Councils for both paddy and milled rice have been reduced from 5% to 2%. In general, there is a potential for expanding both internal and external markets.

5.8.4 Gender Dimensions of Rice Production, Processing and Trading

In Tanzania, the majority of the rice farmers are women and make a significant contribution to food production, while men are more involved in processing and marketing. Women form 80% of the agricultural labour force in rural areas. They play a significant role in rice production in

the country. They are highly involved in all aspects of the rice value chain, particularly planting, weeding, bird scaring, harvesting, processing, and trading. It has been observed that men are mostly involved in land preparation. Both men and women are engaged in rice harvesting and threshing. Generally, women in agriculture experience the following:

- ✓ Performing non-mechanized backbreaking farming operations such as transplanting, weeding, and threshing poses significant health risks for women in addition to inherent household responsibilities; and
- ✓ Difficulty in accessing the critical factors of production such as land, water, credit, capital, and appropriate technologies. It is far easier for men in accessing these inputs compared to women. Therefore, the introduction of labour-saving technologies will take into consideration of gender issues to ensure that gender-sensitive technologies are introduced so that women and the youth are not left out.

5.8.5 Comparative Advantage of Domestic Production

The comparative advantages of the domestic production of rice are:

- ✓ Locally produced rice is of acceptable type and is in higher demand in the region, due to its inherent qualities.
- ✓ Excess rice can be easily exported to the neighbouring markets in the region through the vast and diverse road network and earn foreign exchange and contribute to foreign currency.
- ✓ Production costs can be further reduced by the utilization of cost-effective production technologies such as System of Rice Intensification (SRI) and installation of milling and processing facilities closer to the production areas. Thus, the price of locally produced rice can be equal or cheaper than the cost of imported rice from Asia and elsewhere; and
- ✓ Assist small businesses, enterprises, and communities to create sustainable jobs in production, processing, and marketing of rice as well as in the development of supporting industries, e.g. Repair and maintenance of machinery used in production and processing.

5.9 Challenges and Opportunities Facing Rice Sub-Sector in Tanzania

Several challenges have been identified that act as limiting factors to rice development in Tanzania. These include limited availability and accessibility to improved seed varieties, low use of fertilizers and pesticides, inadequate promotion of time and labour saving technologies including mechanization inputs, insufficient development of irrigation infrastructures and water conservation technologies, sparse development of human resources, weak marketing structures and inadequate access of financial services. Table 5.9 summaries the challenges and opportunities in the rice sector in Tanzania.

Table 5. 9 Rice subsector key Challenges and Opportunities

Area analysed	Challenges	Opportunities
Seeds	• The reduced availability of improved and quality rice seed varieties that are resilient to drought, cold weather, major insect pests and diseases are significant challenges facing the rice sub-sector in the country. Yet there are hundreds of local/ traditional rice varieties grown by farmers in the rain-fed lowland, irrigated low land and upland ecosystems • Funding for plant breeding for the development of suitable varieties is not adequate • Coordination of activities implemented by seed industry development partners are insufficient • The adoption of improved seed varieties which are high yielding is low thus leaving farmers impoverished by being stuck with low yielding aromatic varieties	• Availability of R & D system capable of developing new rice varieties • Presence of Agricultural Seed Agency (ASA) and private seed companies for multiplication, distribution, and marketing of improved seed varieties in the country. • Presence of accredited seed quality control system, Tanzania Official Seed Certification Institute (TOSCI) that can assure the availability of quality registered seeds • Presence of agro-dealers in rural areas that can help in seed distribution • Abundant availability of local germplasm that can serve as a source of variations in developing rice varieties for different purposes • The enormous demand for rice quality seed of improved varieties in the region
Fertilizers	• The use and access of fertilizers (about 15% of rice farmers in Tanzania use fertilizers) is low because of high prices, inadequate knowledge on fertilizer use, untimely availability of fertilizer, scarcity of agro-dealers in rice-growing areas and low purchasing power among farmers • Limited development, supply, and utilization of blended (soil and crop-specific) fertilizers • Limited awareness by farmers on the benefits of adequate and proper management of soil fertility	• The Government's willingness to support availability and affordability of fertilizer to farmers through its programs and projects • Presence of R & D system that can develop fertilizer recommendations • High potential for local manufacturing and blending of fertilizers • A good number of cement companies that could establish operations in the mining, processing, and distribution of lime • Transportation and communication network within the country • Presence of regulatory authorities, e.g. Tanzania Fertilizer Regulatory Authority (TFRA)
Pesticides	• Awareness of Integrated Pest Management (IPM) practices are still low • Knowledge and skills on diagnosis, pesticide use is not adequate among farmers and extension workers • Presence of counterfeit pesticides in the market	• The readiness of farmers to use pesticides • Presence of regulatory authorities, e.g. Tropical Pesticide Research Institute (TPRI) that can assure appropriate and safe use of pesticides

Irrigation infrastructures and water conservation technologies: Availability of water is a prerequisite for increased rice production. Most of the rice production in the country depends on rainfall and other climatic factors. Annual variation in the amount and distribution makes rain-fed rice production susceptible to various manifestations of the climatic changes, including the flooding and/or drought, often within the same season. Drought risk impedes investment, causing stagnation of production at subsistence level.	• Inadequate development of potential areas for irrigation • Irrigation infrastructures are not appropriately utilized • Insufficient research in irrigation and drainage • Limited mapping and development of groundwater resources • Most of the smallholder lands under irrigation are not levelled • Pre-feasibility and feasibility studies for potential areas for irrigation are not well established. Inadequate drive and support for the adoption of most modern technologies	• Availability of water resources • Government's willingness to invest in irrigation development • Presence of National Irrigation Commission (NIRC) • Presence of Irrigation Master Plan Increased global availability of modern irrigation technologies such as solar-powered pumping that if adopted could revolutionize irrigation in Tanzania
Promotion of time and labour - saving technologies, including Mechanization inputs: In Tanzania, about 95% of the farm operations in paddy production are done manually. Planting (both during direct sowing/broadcasting , seeding, and transplanting of seedlings), weeding, harvesting, threshing, and cleaning of paddy are mainly done by hand. The labour input in puddling is high, requiring between 300 and 350-man hours/ha.	Despite its importance, the development of mechanization in the country has been slow as it is held back by several factors. These include: • Agricultural financing from financial institutions are still limited • The number of skilled operators and mechanics for agricultural machinery is not sufficient • Inadequate after-sale services • Service centres/ service providers with full machinery packages are inadequate and under-equipped • Linkages between technology development agencies, manufacturers, distributors, and farmers are still low • Limited development of the private sector and commercially operated machinery hire services • Funds for Research and Development on agricultural mechanization technologies is limited • Review and updating of Tanzania	• Development of policy instruments such as TAMS to address various technological and mechanization inputs • Private sector involvement in supply chains of labour-saving technologies and agricultural machinery is well positioned • Private sector involvement in after-sales and mechanization service delivery is possible • Presence of the Center for Agricultural Mechanization and Rural Technology (CAMARTEC) for quality assurance, fabrication of Agricultural machinery and dissemination of appropriate labour-saving technologies

Similarly, manual transplanting and weeding are labour-intensive, and each such operation requires between 200 and 300-man hours /ha.	Agricultural Mechanization Strategy (TAMS) to address the current needs is still pending • Introduction of time and labour-saving technologies (including mechanization) for small farm sizes	
Marketing and access to financial resources	• Limited market information • Price fluctuations • Irregular and unreliable supply of paddy due to variation in production • Limited access to micro-finance institutions for saving and credit services • Farmers have no influential marketing groups, associations, or cooperatives • Low use of appropriate pre- and post-harvest technologies • Limited access to loans from financial institutions due to lack of collaterals	• The increasing importance of rice as a staple food in rural and urban areas opens opportunities for rice marketing • Availability of improved rice varieties with economic potentials • Improved transport and communication networks • Presence of Tanzania Agricultural Development Bank (TADB), Agricultural Input Trust Fund (AGITF) and other commercial Banks like NMB and CRDB

5.10 Trans-Boundary and Regional Issues

Tanzania is a member of the East Africa Community (EAC) and the Southern Africa Development Community (SADC). Both these regional economic blocs/ communities (REC) allow duty-free trading of rice produced within the region. EAC has set a Common External Tariff (CET) of 75% on the rice imported from outside the area. Tanzania produces enough rice with massive potential for exporting the surplus to other markets within EAC, SADC and other Eastern Africa countries such as Djibouti, Eritrea, Rwanda, Kenya, Uganda, Somalia, and Ethiopia. However, export quantities of Tanzania rice have decreased for the past four years despite an increasing trend of domestic production. This was attributed to the abuse of EAC's rules of origin (RoO) by adulterating Tanzania rice with imported rice from Pakistan. This had prompted Uganda and Rwanda to impose a 75% duty on Tanzania rice. Deliberate efforts have since been taken by Tanzania government to address such tariff and non-tariff barriers on rice, leading to a resolution of the issue with Uganda and Rwanda in May 2017. Despite these events, the demand for Tanzania rice in Uganda, Rwanda and other regional markets is steadily growing; and thus, creating more significant opportunities for scaling up the trading of the locally produced rice.

5.11 Humans and Institutional Capacities

5.11.1 Human capacities

The number of trained personnel working on rice has increased over the years. The rice sub-sector has about 740 professional staff (9 PhD, 150 MSc. and 599 BSc.). More researchers will be needed, especially at the PhD level, which requires further training and facilities. The transfer of technology is of fundamental importance to the future of the rice industry. Training has been

conducted through donor-funded projects and private companies specifically in Rice production, Post harvesting technologies, Agricultural machinery, Gender in rice farming, Water management, Good Agricultural Practices, Marketing and Operation and Maintenance of irrigation schemes. However, there are only 8,323 Agricultural Extension Officers, while the established demand in 2019 was 20,100. The up-scaling of Extension Officers are crucial in providing extension services for rice and other crops. Public and private partners need to continue to implement programmes aimed at training and allocating extension staff to all wards, villages, and irrigation schemes. These staffs need to be facilitated with working tools and opportunities for training to improve their skills.

5.11.2 Institutional capacities

Training institutes and centres of the MoA are actively involved in the participatory extension of improved rice technologies and management of small-scale irrigation schemes through training of farmers and extension staff. These institutes and centres include Kilimanjaro Agricultural Training Centre (KATC) in Moshi, TARI Ukiriguru in Mwanza, TARI Igurusi in Mbeya, TARI Ilonga in Morogoro, TARI Mtwara, TARI Tumbi and Mkindo Farmers Training Centre in Morogoro and the National Irrigation Commission. Whereas the Mkindo Farmers Training Centre offers short term training to farmers, KATC Moshi and the five TARIs provide long term training programmes in Agricultural Production at diploma and certificate levels, which last for two years. TARI Igurusi also offers two specialized diploma courses in 'Irrigation' and 'Land Use Planning'. Upon successful completion of the two-year training, the graduates are employed as front-line extension staff by the local Government Authorities (LGAs).

TANRICE II (2012-2018), a project implemented by JICA and MoA, was aimed at dissemination of rice farming technologies nationwide in partnership with seven (7) agricultural training institutes. TANRICE II used a training approach for disseminating the appropriate irrigated and rain-fed rice cultivation technologies. Besides, the project also promoted rice value chain by developing relevant subject-matter training courses. All these activities were meant for increasing rice production in the country.

The outcomes of the project were:

- Standard training course or modified standard training course, including the pilot courses in 81 irrigation schemes were conducted
- Dissemination of effective technologies for rainfed lowland rice cultivation such as Bund making, Leveling, Straight row transplanting, Straight row direct planting (dibbling & drilling), Application of fertilizer and Improved variety
- Subject-matter training courses (Irrigation scheme management, Gender, Marketing, Agricultural Machinery and Post harvesting technologies) in 129 irrigation schemes were conducted

As a result of the project interventions, the paddy yield under irrigated rice ecosystem increased from 3.2 to 4.5 t/ha, and that in rain-fed lowland from 1.4 to 2.1 t/ha and rain-fed upland rice (NERICA) from 0.5 to 1.2 t/ha.

5.11.3 Rural Poverty Reduction, Food Security and Economic Growth

The potential of local rice production for rural poverty reduction, food security and economic growth is closely related to rice becoming an increasingly important cash crop because:

- The national and regional demands are high
- The price trends are relatively stable in the food market.
- It is relatively less affected by storage pests as compared to other cereal grains such as maize, sorghum, millet, and wheat, commonly used in food security measures.
- The Government of Tanzania has long identified the rice sub-sector as a strategic priority for agricultural development due to its potential for improving food security and income for large numbers of rural households with landholding sizes ranging from 0.5 to 3 ha
- Seed production ventures and seed certification systems (conventional and community based) exist to ensure that paddy farmers have access to quality seeds of improved rice varieties.
- Increase in local production gradually reduced the need for imports

5.11.4 Land Tenure and Water Sources for Irrigation

Tanzania is endowed with an area of 94.5 million hectares of land, out of which 44 million hectares are classified as suitable for agriculture. It is estimated that about 21 million hectares are ideal for rice growing. In 2018, the area under rice production reached 1.1 million hectares. The land belongs to the Government. Land ownership is under the respective villages/districts and governed by the Village Act No.5 of 1999, which recognizes customary rights. Thus, the village governments under the Local Government Authority are the ones responsible for the allocation of the land for various uses. The Government has recently reviewed the land tenure system whereby there is land equity in land ownership for men, women, and youth. Tanzania is endowed with enormous potential water resources constituting of rivers, lakes, and groundwater for irrigation and other uses. Given the existing scenarios of water and land, the irrigation potential in the country is estimated at 29.4 million hectares with varying degrees of potential. Th ere are 2.3 million hectares of high development potential, 4.8 million hectares of the medium potential and 22.3 million hectares of low potential. Among achievements made under ASDP I include the rehabilitation, improvement, and construction of several irrigation schemes, this resulted in an increase in irrigated area from 264,338 hectares (2005/06) to 475,052 hectares in the year 2019.

5.11.5 Seed Production Ventures and Seed Certification Systems

Smallholder rice farmers in Tanzania are increasingly accessing seed of improved rice varieties. Liberalization of the seed sub-sector has enabled the emergence of private seed companies, which are already taking up production and sale of certified seeds such as SARO 5 (TXD 306). The first generation seed classes (pre-basic and basic seeds) are being multiplied and marketed by both the public and private seed producers. Agricultural Seed Agency (ASA) plays a significant role in increasing the basic seeds of all the improved rice varieties. In 2017/18, ASA produced and marketed about 987 MT of improved rice seeds. These efforts are being supported by Development Partners such as Alliance for a Green Revolution in Africa (AGRA) and Bill and Melinda Gates Foundation. Breeder (pre-basic) seeds are multiplied at TARI, Ifakara and Dakawa. In addition to certified seeds, Quality Declared Seeds (QDS) are produced from the

certified seeds by registered farmer-seed producers in groups or individually and sold to ASA, agro-dealers, and farmers in the same locality. Among the rice-specific action areas identified for implementation under ASDP II are improving access to and use of high-quality seeds through engaging the private sector and farmer organizations in seed supply chains and strengthening the national and local agricultural input supply systems to improve access to quality crop inputs (seeds, fertilizer, agrochemicals and tools).

Tanzania has set up procedures and regulations to ensure that the seeds reaching the farmer are of prescribed quality. On this basis, Tanzania Official Seed Certification Institute (TOSCI) of the MoA which is accredited by OECD and ISTA has the power and responsibilities to enforce the Seed Act, 2003 and regulations on seed certification. Since the rice seed regulations and standards are harmonized with that of the EAC and SADC regions; the rice seeds produced in Tanzania by both public and private seed companies, are traded across the region.

5.11.6 Research, Technology Dissemination, genetic resources conservation

Research technology development and dissemination are practised through Client-Oriented Research and Development Management Approach (CORDEMA). This approach builds a more significant farmer influence and accountability into the choice of research programmes as well as improved management and monitoring of research. The linkage between researchers, extension and farmers is provided through Technology Information Transfer at TARI Centers, with enhanced communication capability. Its core functions include assembly, assimilation, and dissemination of relevant agricultural technologies from TARI centres.

Collection and conservation of germplasm have been limited to a few crops due to poor finances and weak linkages. For this reason, the germplasm collection and preservation for rice has been undertaken by the respective research centres working on rice under the Tanzania Agricultural Research Institute (TARI) in collaboration with interested international research institutions. A wide range of germplasm of about 420 genotypes has been collected from within the country and from IRRI, IITA and Africa Rice. The materials are periodically rejuvenated, field evaluated, characterized, and conserved at TARI Ifakara and TARI Dakawa. Genotypes with desirable traits are incorporated through rice breeding programs. More collection missions are needed to be conducted, and concerted efforts need to be put in place by the rice research programme in collaboration with National Plant Genetic Resource Centre (NPGRC) to collect, characterize and conserve germplasm for future mining of novel genes against biotic and abiotic stresses. In this regard, more funds are needed for collection and conservation and to build capacity in terms of infrastructure facilities for both the rice research programme and the NPGR. In this endeavour, TARI Ifakara, which is the coordinating Institution for rice research, will need to render close collaboration with the NPGR to ensure that the same germplasm resources are conserved at the NPGRC.

Participatory breeding methods and advanced biotechnology tools need to be deployed following the national bio-safety framework for selecting and developing high yielding varieties with desirable consumer/market qualities. These qualities include post-harvest and production attributes such as milling %age, resistance to lodging, early maturity, and resistance to major

biotic and abiotic factors. Developed and released varieties are registered with the Registrar of Plant Breeders Rights at MoA.

5.11.7 Weed, Pests and disease and soil fertility management

Research on soil fertility has been done to establish optimal rates of inorganic fertilizers for lowland rice in some areas. Recommendations on the use of both the organic and inorganic fertilizers need to be developed mainly in intensive rice producing areas. More work in revising fertilizers recommendations is required given the increased prices of fertilizers and new brands of fertilizers introduced into the market. All-inclusive packages for control of soil erosions are available and need to be adapted to conditions of the ecosystem. Mineral imbalances in rice-growing areas have led to Iron, Sulphide, Boron, Manganese and Aluminium toxicity. Integrated soil fertility and soil–water management options will thus be emphasized for sustainable natural resources. Rice production is affected by a wide range of pests and diseases. The severity depends on location, season, variety, farming system, and weather. Rice Yellow Mottle Virus (RYMV), which is indigenous in Africa, is a major scourge of lowland rice and can sometimes lead to total crop failure. Rice blast caused by *Pyricularia oryzae* is also another severe disease in lowland rice. Pests are another biotic stress that causes considerable losses in rice production. Yield losses ranging from 30 to 100 % have been recorded. Most damage to rice is produced by stem borers (*Chillo spp*.), African rice gall midge (*Orseolia oryzivora*), rodents and birds. Integrated pest management options developed or verified in the country need to be efficiently disseminated to farmers. Also, other available improved crop management options for irrigated lowlands, rain-fed lowlands and rain-fed upland ecosystems will be repackaged and distributed, where necessary.

5.11.8 Rise advisory services: Extension, NGOs, and Agri-business

The Local Government Authorities (LGAs) have primary responsibility for ensuring that the extension services are adequately provided to smallholder farmers. The central or local government controls most of the extension service provision for smallholders. However, some Non-Governmental Organizations (NGOs) can source funds independently. Several extension methodologies that have demonstrated good prospects of success are currently being used by various programmes/projects in parts of the country. Because of this, further productivity enhancement will require an efficient extension service which would facilitate the increased transfer of appropriate technologies as well as the application of other research results. In recent years, Agri-business organizations have also been increasingly contributing to the delivery of agricultural services and technologies.

5.12 Stakeholders in rice production System

5.12.1 Identified and mapped stakeholders for Rice

Farmers (individuals or in groups/FBGs/CBOs—MVIWANYA/AMCOS); TCDC; TBS; NEMC; National Irrigation Commission (NIRC); TMDA; WMA; LGAs; MoA; Ministry of Water and Irrigation; Minister of Lands, Housing and Human Settlements; Buyers; Research Institutions--Ukiriguru; Financial Institutions—CRDB, National Microfinance Bank (NMB); Tanzania Investment Bank (TIB); Seed Companies—Agricultural Seed Agency (ASA); NGOs—Marketing Infrastructure, Value Addition and Rural Finance Support (MIVARF), Grain to Grow Foundation (GGF); Agro-dealers.

5.12.2 National Stakeholders in Rice production Systems

Farmers; LGAs; National Irrigation Commission (NIRC); Kilombero Plantations Limited (KPL); Projects such as the Joint African Project, a Game-changer for Young Rice Producers in Morogoro by young rice growers in Kilosa District who are benefiting from the *Partnership for Sustainable Rice Systems Development in Sub-Saharan Africa* project. The project is aimed at realizing more efficient, sustainable, and productive rice systems in Africa to increase food security and enhance sustainable development of the rice food chain among the smallholder farmers, especially youth. In Africa, the three-year project was executed in Tanzania, Benin, Cameroon, Côte d'Ivoire, Guinea, Kenya, Mali, Nigeria, Senegal, and Uganda; FAO; The National Strategy for Involvement of Youth in Agriculture of 2016; Expanding Rice Production Project (ERPP)—in 2015 in an effort to boost rice production, increase food security and strengthen the country's agricultural sector; the Global Agriculture Food and Security Program—it is specifically focused on improving agricultural practices for small-scale farmers and farms run by women; Sokoine University of Agriculture SUA)—publications and theses; Ohio State University—publications and these; USAID; Tanzania Staples Value Chain (NAFAKA) project—is being undertaken in partnership with Kilombero Plantations Ltd (KPL funded by USAID; The WWF-ICRISAT Project in Hyderabad, India, helped to establish SRI demonstration plots and train KPL staff and farmers in Tanzania; MoA; Buyers; Research Institutions—TARI Ukiriguru; Financial Institutions—CRDB, National Microfinance Bank (NMB), Tanzania Investment Bank (TIB), and Tanzania Agricultural Development Bank (TADB); Seed Companies—Agricultural Seed Agency (ASA); NGOs—Marketing Infrastructure, Value Addition and Rural Finance Support (MIVARF), JICA, and Grain to Grow Foundation (GGF); Agro-dealers.

5.13 Key findings in the pilot projects for sustainable rice intensification in Mara Region

Preliminary study in the Mara region finds that rice is among the top five priority food crops in Rorya, Bunda, Bariadi, and Busega districts and is mainly grown under rainfed conditions although irrigated schemes also exist. The crop is produced twice a year for irrigated system farmers and once for the rain-fed system. In rice production, we find that the majority (>70%) of rice farmers use local seed system as opposed to <30% who use improved seed system—mostly using SARO 5 variety. The study finds that most of the rice is marketed internally.

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6 UGANDA

6.1 Introduction

Rice growing is relatively new to most farmers in Uganda (MAAIF, 2012). Production started to increase in the 1970s after the Government of Uganda established Kibimba, Doho and Olweny irrigation rice irrigation schemes currently located in Bugiri, Butaleja and Dokolo districts respectively (Oonyu, 2011). Rice production has since increased over the years, especially with the introduction of upland varieties in 2003 (Ahmed, 2012; MAFAP, 2013). The increasing rate of rural-urban migration caused by the fast-growing population rate (3.7%) and increasing urbanization and changing food habits in Uganda has led to the escalating demand for rice in Uganda (World Bank, 2020). Rice has therefore become a major foodstuff in urban areas where it is consumed a lot in homes, schools, hospitals, and the army. Rice consumption in Uganda increased significantly from 36,000 tonnes in 1990 to 414,000 tonnes in 2017, at an average annual rate of 10,498 tonnes.

In Uganda rice is grown under three main ecologies, namely rainfed lowland, irrigated lowland and rainfed upland. Lowland rice, also known as paddy rice, whether rainfed or irrigated is grown in bunded levelled fields that are flooded throughout the growing season up to 7 to 10 days before harvest. Paddy rice is grown in most parts of the country in lowlands areas with high moisture contents through the growing season. The rainfed lowland ecology is mostly found at the fringes of wetlands in Eastern Uganda and the foot hills of Mt. Elgon (MAAIF, 2012). In such lowlands rice is manly grown under irrigation where irrigation infrastructure has been developed for example in is the Doho rice scheme. At this rice scheme the entire wetland was converted to irrigate rice production (MAAIF, 2012). On the other hand upland rice varieties are grown in the rainfed upland ecology mainly under rainfed situations in unbunded fields that are either level or sloping. The rainfed upland ecology comprises mainly occur in Northern Uganda, the West Nile sub-region, Mid- and South Western Uganda and Central Uganda (MAAIF, 2012). Figure 6.1 shows the trend of paddy rice area harvested and rice demand in Uganda

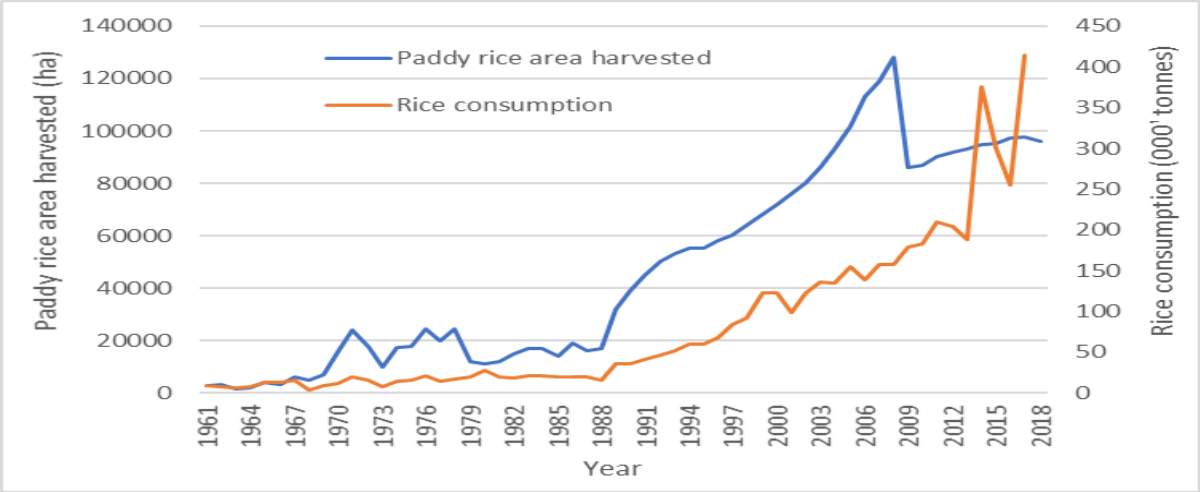


Figure 6. 1 Trends of paddy rice area harvested and rice demand in Uganda

Between 1990 and 2018, paddy rice production increased in Uganda from 54,000 to 260,786 tonnes; at an annual growth rate of 7995 tonnes which has mainly been due to extensive rather than intensive production system (Figure 6.2). This means that growth in rice production in the country is mostly due to the expansion in area under crop than the increase in yield. In the same period harvested paddy rice increased from 39,000 to 92,960 ha at a growth rate of 2,100 ha per year. Between 1990 to 2008 milled rice yield averaged to 1400 kg/ha which increased to an average of 2500 kg/ha from 2009 to 2018 (Figure 6.2).

Rice growing districts in Uganda include Amuru, Lira, Pallisa, Hoima and Bugiri where cultivation is dominated by small-scale farmers, growing (80%) (Table 6.1) (UBOS, 2010). The farmers are grown in plots of less than 2ha per household often adjacent to wetlands. Here the small scale farmers use simple technologies such as little or no fertilizer use, seeds of poor quality and with little or no irrigation and poor water management practices (MAAIF. 2012; Ahmed, 2012; Oonyu, 2011; MAAIF, 2009). The medium-scale rice farmers with 2-6 ha are only 15% of rice farmers and they generally use mechanized land preparation but like the small-scale farmers they still employ simple technologies for the rest of the farm activities (MAAIF, 2012). The remaining 5% are large-scale farmers that grow rice on farm sizes of over 6 hectares including in private rice schemes with acreages of over 1000 hectares like Kibimba rice scheme owned by Tilda Uganda Limited, the largest rice producer and exporter of Ugandan rice (Ayoki, 2012). They use mechanized farm operations as well as farm inputs to improve although fertilizer use is still low (MAAIF, 2012). According to Ayoki, (2012), Tilda produces and processes rice for sale in supermarkets in Uganda and also for exports the produce.

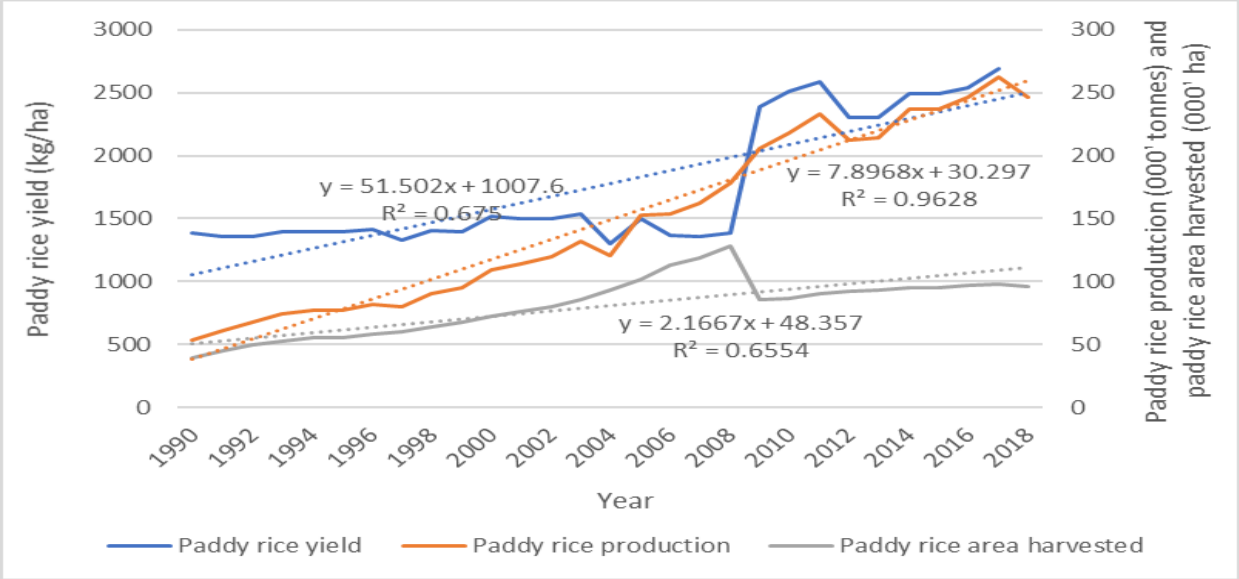


Figure 6. 2 Trend of paddy rice production, area harvested and yields in Uganda

Table 6. 1 Top rice growing districts in Uganda, 2008/2009 (Source: UBOS, 2010)

District	Area (Ha)	Production (Mt)
Bugiri	5,853	4,185
Busia	1,438	11,188
Iganga	3,676	31,492
Pallisa	6,247	22,865
Soroti	2,017	24,689
Tororo	1,773	16,176
Butaleja	1,761	3,433
Kaliro	2,555	2,876
Namutumba	1,583	2,561
Lira	6,703	8,009
Pader	3,036	5,029
Amuru	7,771	19,042
Oyam	1,104	3,667
Hoima	5,919	10,911
Kibaale	1,762	2,917
Other districts (combine d)	21,888	21,696
Uganda	**75,086**	**190,736**

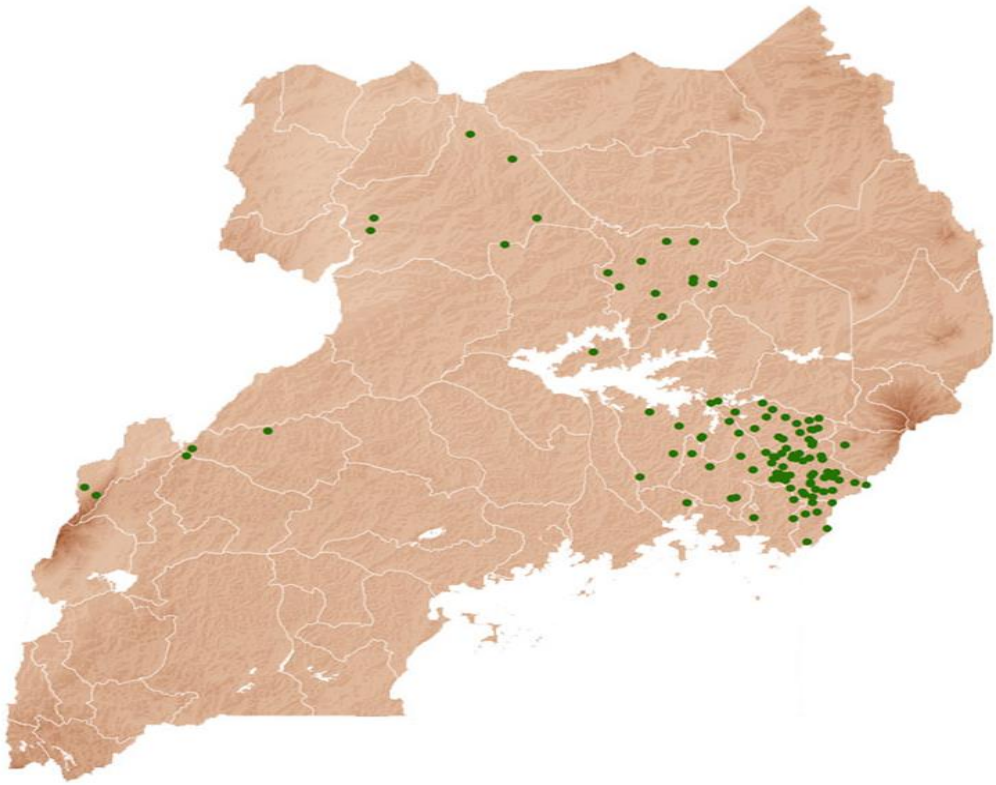


Figure 6. 3 Major Rice growing areas in Uganda. One (1) dot represents 1000 ha. (source: CARD, 2020)

Uganda's rice production deficit is met through imports, mainly from Tanzania and Pakistan. From 1997 to 2019, rice imports increased from 32,500 tonnes (39% of the total rice consumption) to 125,000 tonnes (27% of the total rice consumption). In 2018, rice exports to Uganda from Tanzania, Pakistan, India, Thailand and United Arab Emirates were 79.6, 10.8, 6.0, 3.1 and 0.4% respectively of the total import quantity (Tridge, 2020). S.W.T. Tanners Limited is the leading importer of Pakistani rice in Uganda (Ayoki, 2012). Tilda Uganda Limited also imports rice mainly from Pakistan, repackages it and sells it to leading supermarkets in Uganda (Ayoki, 2012). Uganda mainly imports 'brown' rice (i.e. an intermediate product after rice has been milled and husks and bran removed). Processing is done in the country and the processed rice is packed and sold on the markets.

About 45% of the total milled rice that Uganda imports annually is 'broken rice' because price of broken rice on Ugandan markets is lower than whole grain rice. Uganda also exports white rice to mainly the Democratic Republic of Congo (DRC) and South Sudan. In 2018, Uganda exports of rice was 49. 7% to DRC's, 49.7% to South Sudan (44.7%), to Rwanda (5.2%), Central African Republic (0.3%) and Sudan (0.1%) (Tridge, 2020) which included both locally grown rice and some of the imported rice. However, Uganda still remains a net-importer of rice. Figure 6.4 shows that in the 1990s, the net rice import was identical to the export itself. However in early 2000s the net import started to decline as rice export started to pick up.

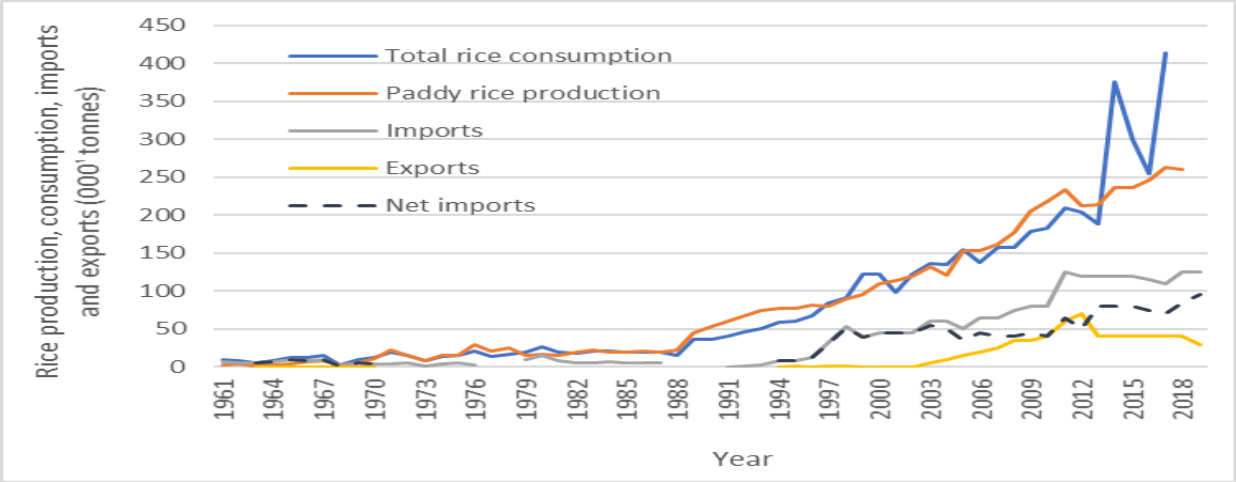


Figure 6. 4 Trends of rice demand, imports, exports, and paddy rice production in Uganda

6.2 National rice trading, markets and prices

About 40% of the rice produced by the small-scale farmers is used for food, seed for the subsequent seasons and for barter trade with neighbours (Ahmed, 2011). The remaining 60% is either sold threshed directly to middle men or milled by the farmers and sold to traders and consumers (Ahmed, 2011). Rice trading in Uganda is driven by the private sector and the market supply chain and is provided in Figure 6.5 (MAAIF, 2012). Table 6.2 shows the current rice prices on the markets in Uganda according to variety or brand. Challenges of low productivity have resulted into Ugandan rice being more expensive in the local markets compared to pre-taxed imported rice. Additionally, local rice is of low quality due to existence of impurities (e.g. stones), broken rice and packing of mixed varieties together, as such the local rice is less competitive even in local markets (MAAIF, 2012).

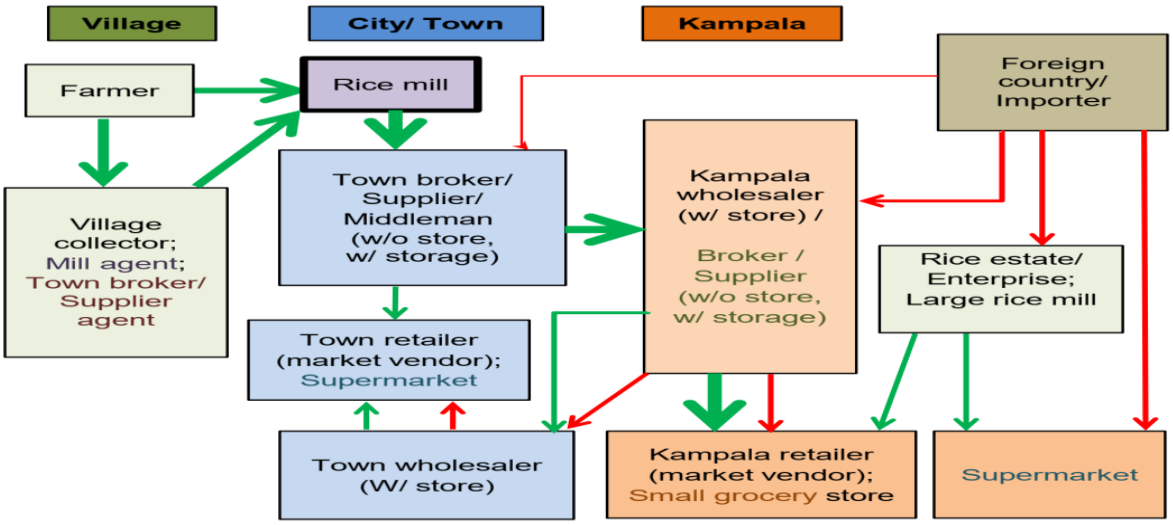


Figure 6. 5 A typical market for rice in Uganda (Kikuchi et al., 2013)

Table 6. 2 Rice varieties and brands sold in Kampala, Uganda

Variety/brand	Source	Supplier	Retail price (UGX)[a]
Supermarkets			
Super rice	n.a[b]	Mutima Food Processors Ug	59,000/= per 10 kg
Super rice	n.a	Kasawo grain millers	31,000/= per 5 kg
Tilda rice	n.a	Kibimba Ltd	57,000/= per 10 kg
Super rice	n.a	Kirunga group Company	12,000/= per 2 kg
Super rice	n.a	Maganjo grain millers	36,000/= per 5 kg
Super rice	n.a	Numa feeds ltd	34,600/= per 5 kg
Kibimba classic aromatic	n.a	Kibimba Ltd	27,000/= per 5 kg
SWT-P (15% broken)	Pakistan	S.W.T. Tanners Ltd	30,500/= per 5 kg
SWT-SG (10% broken)	Pakistan	S.W.T. Tanners Ltd	35,500/= per 5 kg
SWT-1 (15% broken)	Pakistan	S.W.T. Tanners Ltd	27,000/= per 5 kg
Basmati	India	Tania	55,000/= per 5 kg
Daawat Biryani rice	India	Orkaspree Ltd	58,500/= per 5 kg
Open markets and shops			
Super - 1st grade[1]	Uganda	n.a	5,000/= per kg
Super - 2nd grade[†]	Uganda	n.a	4,500/= per kg
Super - 3rd grade[‡]	Uganda	n.a	4,000/= per kg
Kaiso - 1st grade[☆]	Uganda	n.a	4,000/= per kg
Kaiso - 2nd grade	Uganda	n.a	3,500/= per kg
Super	Tanzania	n.a	5,000/= per kg
S.W.T rice	Pakistan	S.W.T tanners Ltd	5,500/= per kg

S.W.T rice	Pakistan	S.W.T tanners Ltd	5,000/= per kg
All milled rice at Doho	Uganda	Doho rice irrigation scheme	Ranges from 2200 to 2400/= per kg

- [a]1 UGX = 0.00027 USD
- [b]n.a = information is not available
- *Whole grain rice with no stones or other chaff, requires no cleaning prior to cooking
- †Is a mixture of whole grain rice and broken rice, bigger percentage of whole grains. Requires some cleaning to remove a few stones and chaff
- ‡Is mostly broken rice that requires considerable cleaning to removes stones and chaff prior to cooking
- ☆Is a mixture of whole grain rice and broken rice and requires less cleaning when compared to Kaiso – 2nd grade.

6.3 Policies and strategies for rice production

As a strategy to reduce household poverty and reduce rice imports into the country, the Government has directly intervened since 2003 to promote rice growing. Through government interventions production of upland rice has enabled increased supply of local rice in Uganda (MAAIF, 2012). Rice has since gained prominence as a rural cash crop and an urban food item. Regional trade blocs/agreements are an increasingly significant feature of the world trade system. The EAC is one such regional blocks and as an intergovernmental organization comprising of Burundi, Kenya Rwanda, Tanzania and Uganda and recently South Sudan is well placed to promote agricultural production including rice value chain regionally and beyond (Khorana et al., 2009) once well operational Customs Union, a Common Market, subsequently a Monetary Union and ultimately a Political Federation of the Partner states are established.

Under the EAC Customs Union that came into force in 2005, Partner states agreed to: (i) abolish tariff and non-tariff barriers in order to deepen and strengthen trade among themselves, and (ii) establish a Common External Tariff (CET), where imports from countries outside of the EAC are subject to the same tariff when sold to any EAC Partner State (East African Community Secretariat, 2004). A list of sensitive products whose importation from outside the EAC that may negatively affect local production can be mitigated through this regional arrangement and the commitment by the Partner States. The sensitive products which include rice have been categorized and duty rated at over 25%. Rice was set at a CET of 75% advalorem duty or USD 345 per metric tonne, whichever is higher (Table 6.2). Before CET, the tariff on rice imports in Uganda was 15% (Table 6.4). Under the CET, rice from Tanzania enters Uganda duty free. The EAC's CET is therefore the most important measure affecting rice markets in Uganda.

However due to drought in 2017, some rice millers convinced the government to allow them to bring into the country semi-milled rice (i.e. unpolished) at lower duty rates than EAC's CET of 75% advalorem duty or USD 345 per metric tonne. This was to help handle the issue of food insecurity caused by drought and adverse effects on agricultural production and because several rice mills in the country received low volumes of rice to mill, thus affecting their investments. Initially the government allowed this for six (6) months for the semi-milled rice imports and then extended to this year (2020) for companies who also grow own local rice growing and/or support

rice farmer groups. Therefore currently in Ugandan market, some imported rice brands/types are cheaper or equal to locally produced rice brands/types (Table 6.3).

Table 6. 3 Tariff lines for importation of rice before and after the implementation of EAC Customs Union Protocol (CET, % p.a) (source: East African Community, 2017; Shinyekwa and Katunze, 2016)

Product	Duty rate before establishment of the EAC Customs Union	EAC Customs Union CET rate
Rice in the husk (paddy or rough)	15	75% or $345/tonne whichever is higher
Husked rice (brown)	15	75% or $345/tonne whichever is higher
Semi-milled or wholly milled rice whether or not its polished or glazed	15	75% or $345/tonne whichever is higher
Broken rice	15	75% or $345/tonne whichever is higher

Coalition for African Rice Development (CARD), a consultative group of bilateral donors and regional and international organizations, supports the efforts of sub-Saharan African (SSA) countries to increase rice production. CARD's initial (Phase1) target was to double rice production in SSA to 28 million tons per annum by the year 2018 (CARD, 2020). CARD Phase2, which started in 2019, has a renewed target of further doubling rice production in SSA by 56 million MT for the next 12 years (CARD, 2020). CARD supports member countries to prepare their National Rice Development Strategy (NRDS). Uganda became a member of CARD in 2008; the same year it developed its National Rice Development Strategy (NRDS) that laid out its strategy for promotion of rice production between 2008 to 2018. Since its development, Uganda's NRDS has been revised twice; in 2009 and in 2012. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) established a Rice Industry Secretariat (RIS) responsible for planning and implementing the NRDS. A Regional Rice Research and Training Centre was established in 2010 at the National Crops Research Institute (NaCRRI) with the aim of training farmers, extension agents and researchers of CARD member states in appropriate rice technologies.

Derived from Uganda's National Development Plan (NDP) 2010/11 – 2014/15 that recognizes and prioritizes agriculture as a primary sector to drive Uganda's development, and the Agriculture Sector Development Strategy and Investment Plan (DSIP) 2010/11 – 2014/15 in which rice was identified as one of the strategic enterprises to meet its objectives of increasing rural incomes and livelihoods and improving household food and nutrition security, Uganda's NRDS (2008 – 2018) sought to make Uganda self-sufficient in quality rice production with a strategic target of increasing rice production from the 177,800 MT of un-milled rice in 2008 to 680,000 MT by 2018 (MAAIF, 2012). It aimed to achieve that through: (i) strengthening the institutional framework, (ii) improving research, technology dissemination and capacity building, (iii) increasing production, multiplication and dissemination of certified seed, (iv) improving marketing and distribution of fertilizer and sustainable soil management, (v) improving irrigation

and water management, (vi) improving post-harvest handling, processing and marketing, (vii) improving access to and maintenance of agricultural equipment, (viii) improving access to agricultural finance, (ix) supporting policy development, and (x) ensuring conservation of the environment.
In 2019, the Ugandan Government started the process of developing a new NRDS for the period of 2020 to 2030. In the new strategy, environmental sustainability is among the priority themes. This follows President Museveni's directive that smallholder rice farmers should stop growing rice in wetlands.

Rice is a major product in Uganda for poverty reduction and food security (Ahmed, 2012). As such, rice production was identified as a major intervention in the Agriculture Sector Strategic Plan (ASSP) 2015/16 – 2019/20, also known as, ASSP II. ASSP II a flagship plan for investment and development of the agricultural sector and is in line with the National Development Plan names rice as one of the priority commodities to be focused on during that period (MAAIF, 2015). A target of 680,000 metric tonnes of rice production by the year 2020 was planned to be achieved through: multiplication and distribution of improved foundation seed, mechanization of rice production, investment in irrigation infrastructure starting with Eastern Uganda, provision of extension services to farmers, promotion and distribution of appropriate post-harvest technologies, increasing access to credit by rice farmers, traders and processors and promoting collective marketing for high quality rice (MAAIF, 2015). The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is currently reviewing ASSP II in preparation of ASSP III (i.e. ASSP 2020/21 – 2024/25).

In 2016, MAAIF formulated the National Agricultural Extension Policy (NAEP) aimed at "establishing a high quality, well-coordinated and harmonized pluralistic agricultural extension delivery system to promote application of appropriate information, knowledge, and technological innovations for commercialization of agriculture, ensuring food security, expanding exports and contributing to socio-economic transformation and welfare of the population." To operationalize the NAEP, MAAIF concurrently developed the National Agricultural Extension Strategy (NAES). MAAIF also developed guidelines that agricultural extension service providers should follow in undertaking their duties and standards that define the acceptable level of performance Agricultural Extension and Advisory Services can be monitored and assessed (MAAIF, 2016a).

MAAIF formulated the National Fertilizer Policy in 2016 with four (4) specific objectives, namely: (i) to strengthen the capacity of farmers to engage in safe, profitable and sustainable fertilizer use, (ii) to strengthen the capacity of suppliers to deliver fertilizers at the right quantity, quality and time and in a cost-effective manner, (iii) to enhance the regulatory and institutional capacity to ensure the quality, environmentally safe supply and use of fertilizers to achieve sustainable productivity and production, and (iv) to effectively manage fertilizer-related knowledge (MAAIF, 2016b). On the side of seeds, the Seed and Plant Act was enacted in 2006. The Act provides for the promotion, regulation and control of variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and planting materials. In 2014, the Plant Variety Protection Act, that provides for the promotion of development of new plant varieties and their protection as means of enhancing breeders' innovations and rewards through granting of plant breeders' rights and other related matters, was enacted.

More recently in 2018, MAAIF formulated the National Seed Policy whose objectives are to: (i) to strengthen research and development for the seed sector, (ii) to strengthen capacity of the key players along the seed value chain to achieve an effective and efficient seed sector, (iii) to strengthen the seed quality control system along the entire value chain, and (iv) to enhance knowledge and information management for the seed sector (MAAIF, 2018).

Current and former wetland areas are key paddy rice production areas in Uganda. Regulation of wetland use therefore needs to take into consideration both environmental sustainability and productive use of wetlands. In 1995, the government adopted the National Policy for the conservation and management of wetland resources. The policy aimed at: (i) establishing the principles by which wetland resources can be optimally used now and in the future, (ii) ending practices which reduce wetland productivity, (iii) maintaining the biological diversity of natural or semi-natural wetlands, (iv) maintaining wetland functions and values, and (iv) integrating wetland concerns into the planning and decision making of other sectors (Ministry of Natural Resources, 1995).

In 1995, the National Environment Act, Chapter 153, was enacted to provide for sustainable management of the environment and to establish an authority as a coordinating, monitoring and supervisory body for that purpose (GoU, 1995). The National Environment Management Authority (NEMA) was thus established. The Act restricts activities in wetlands unless a person has written permission from the National Environment Management Authority (NEMA). Under section 19 of the Act, NEMA is required to conduct an Environment Impact Assessment of the person's planned activity to determine the effects of that activity on wetlands and the environment in general (GoU, 1995). Under the Act, NEMA was required to establish guidelines for identification and sustainable management of all wetlands in Uganda. NEMA was also required to compile a national register of wetlands, their characteristics and importance, and with the District Environment Committee, to declare any wetland that needs to be protected from human activities. None of the above requirements have been accomplished yet.

Since there was no enabling law for implementation of the National Wetland Policy 1995, in 2000, the National Environment (Wetlands, River Banks and Lake Shores Management) Regulations, No. 3/2000 was enacted. The objectives of the regulations were to: provide for the conservation and wise use of wetlands and their resources in Uganda; give effect to clause 2 of article 237 of the Constitution of Uganda: specifically, "the Government or a local government as determined by Parliament by law shall hold in trust for the people and protect natural lakes, rivers, wetlands, forest reserves, game reserves, national parks and any land to be reserved for ecological and touristic purposes for the common good of all citizens"; ensure water catchment conservation and flood control; ensure the sustainable use of wetlands for ecological and tourist purposes for the common good of all citizens; ensure that wetlands are protected as habitats for species of fauna and flora; provide for the regulated public use and enjoyment of wetlands; enhance research and research related activities; and minimize and control pollution (GoU, 2000). These Regulations prohibit central government or local governments from leasing out or otherwise alienate any wetland; this however has been abused.

In 2019, the new National Environment Act was enacted to repeal, replace and reform the law relating to environmental management in Uganda. The Act also seeks to: (i) provide for the management of the environment for sustainable development, (ii) continue the National Environment Management Authority (NEMA) as a coordinating, monitoring, regulatory and supervisory body for all activities relating to environment, (iii) provide for emerging environmental issues including climate change, the management of hazardous chemicals and biodiversity offsets, (iv) provide for strategic environmental assessment, (v) address environmental concerns arising out of petroleum activities and midstream operations, (vi) provide for the management of plastics and plastic products, (vii) establish the Environmental Protection Force, (viii) provide for enhanced penalties for offences under the Act, and (ix) provide for procedural and administrative matters.

Over the past few years, President Museveni has sounded warnings and given eviction directives to encroachers on wetland areas. In May 2018, the President issued a directive that farmers must stop using wetlands to grow rice, urging that they should use either irrigation or grow upland rice. On April 22nd, 2020, President Museveni gave the most recent directive on wetlands. His Excellency directed the Minister for Water and Environment to evict all encroachers on wetlands, lake shorelines, river banks and government forest with immediate effect to mitigate the effects of climate change, with the exception of people in historical wetlands in Busoga, Bukedi and Kigezi sub-regions whom earlier governments allowed to grow crops in these wetlands. Butaleja district, where Doho rice irrigation scheme is located is comprised in Bukedi sub-region.

This most recent presidential directive came after: (i) the current rise in Lake Victoria water level that started last year from 12 m on 1st October 2019 to 13.32 m by 30th April 2020 causing a lot of flooding and destroying a lot of property along the shorelines, and (ii) two (2) floating biomasses hit Owen Falls dam and temporarily halted electricity generation. The argument is that over the years, there has been increasing loss of forest cover; increasing encroachment on wetlands, lakeshores and river banks; plus, increasing use of poor land use practices. As such, there is increasing soil erosion because of increasing runoff rates due to reduced rates of infiltration of water into the soil. Thus, water bodies silt up easily leading to reduction in their storage capacities. As such, during this previous rainy season (March 2020 to May 2020), inflows into Lake Victoria might have significantly increased and significantly increased the lake's water levels. Research needs to be conducted to back this argument.

If the presidential directive is enforced this time around, several small holder farmers including rice farmers will be affected. Also, rice production in the country will be affected since as already seen above, most of the increase in rice production especially paddy rice production in the country has been as a result of increasing the area under rice cultivation, rather than intensifying production systems.

6.4 Selected pilot for intensification: Doho irrigation scheme

Doho rice irrigation scheme (0.88333° N, 34° E, 1,105 m), originally a wetland, is located in Mazimasa sub-county, Butaleja District in the Eastern Region of Uganda. It was established in 1976 by the Government of Uganda to enable farmers utilize the excessive water from River Manafwa that was causing flooding in the Doho area. Doho rice irrigation scheme covers a total area of 2500 acres of land. The scheme is under the irrigated lowland ecology, and it uses water diverted from River Manafwa for irrigation. River Manafwa originates from Mt. Elgon in Mbale. Doho has a water permit that is kept by the Ministry of Water and Environment (MWE).
The scheme has a reservoir whose storage capacity can supply water to the scheme for about 14 days during periods of low flows of River Manafwa. Water distribution from the sources is by gravity. Basin irrigation is used in the scheme to grow paddy rice varieties. Doho rice irrigation scheme is a public scheme that comprises of about 4000 small-scale farmers operating on farm sizes ranging from 0.25 to 3 acres; average land holding is currently 0.5 acres. The scheme is comprised of 11 blocks. Only rice is grown in the scheme. The scheme was rehabilitated by the government from September 2011 to July 2013.

6.4.1 Crop calendar

The start of each growing season depends on availability of adequate water for rice irrigation in River Manafa; ultimately it depends on the onset of rains. Rice at Doho is grown in two (2) seasons per year. The first season start early March and harvest is done in August, whilst the second season starts in September and harvest is done in February of the following year. Production statistics of Doho are as shown in Figures 6.6 and 6.7. There was no production during the period the scheme was being renovated; from September 2011 to July 2013. Doho rice irrigation scheme on average produces about 7200 tonnes of unmilled rice annually, which is equivalent to about 4700 tonnes of milled rice. The yield of milled rice in Doho is averaged at about 1000 kg/acre (2471 kg/ha); similar to the national average of the past ten (10) years.

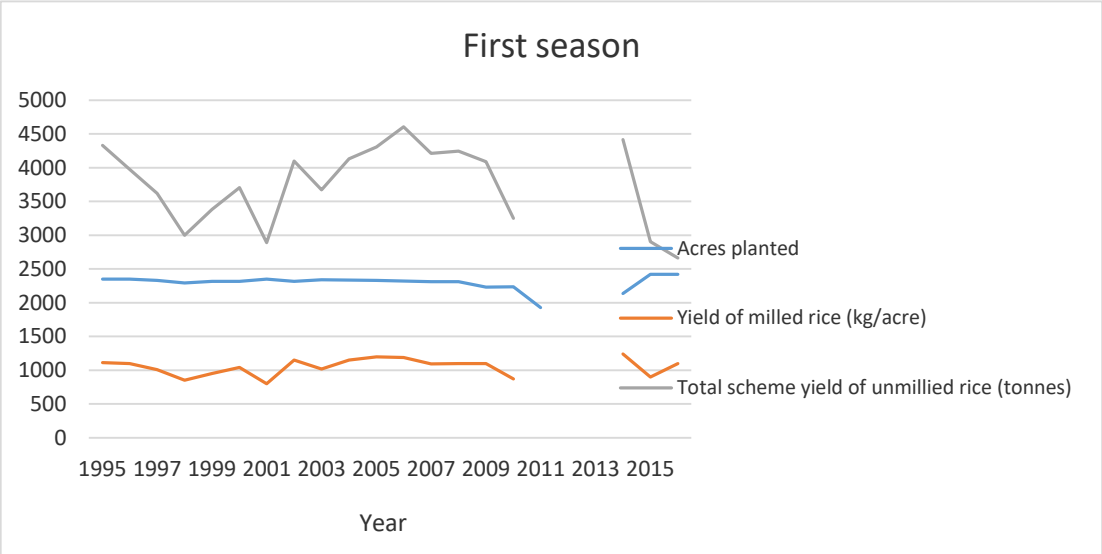


Figure 6.6 Production characteristics of Doho rice irrigation scheme for the first season over the years

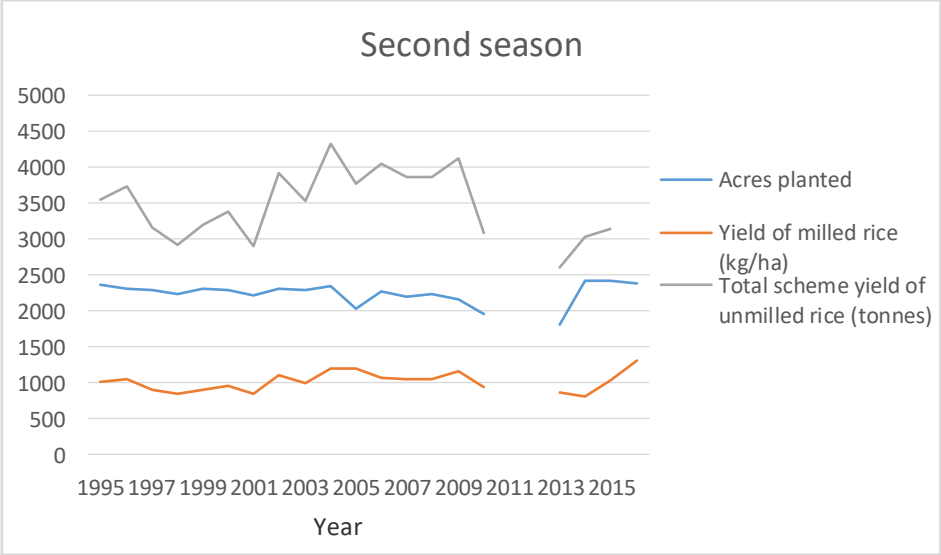


Figure 6. 7 Production characteristics of Doho rice irrigation scheme for the second season over the years

6.4.2 Rice varieties grown in Doho

Rice varieties grown in Doho rice irrigation scheme are as shown in Table 5. Currently, the most grown variety in Doho is K98 although farmers rotate varieties season after season. Although K98 is a non-aromatic variety, farmers mentioned that it is resistant to droughts, gives long grains, is tasty, shines when processed and has a high market demand. However, K98 is not favorable during periods of high rainfall. Farmers mentioned that K98 plants increase rapidly in height during periods of high rain such that winds can easily cause them to topple over thus causing plant losses. During seasons of high rainfall therefore, farmers grow K85 (Kaiso) instead. Most of the farmers interviewed rotated K98 with K85. K85 (Kaiso) is also a non-aromatic variety. Farmers mentioned that K85 is a heavy variety (i.e. grains weigh more), and although it's not so good in taste, on the Ugandan market, its most favorable to low-income earners due to its lower price (Table 6.3) and also because it expands when cooked.

WITA 9 is a new variety that farmers admitted to not knowing so well because just a few farmers have so far tried growing it. It is also a non-aromatic variety. Those who have grown it mentioned that it grows very well, it is heavy, it doesn't grow very tall hence not so much disturbed by birds and neither do plants easily topple in wind conditions, when milled the grains 'shine', and it grows faster. However, its seed are not yet readily available to farmers, and farmers reported that this variety does not want to be flooded a lot as is the norm in the lowland irrigated ecology.

K5 is the least grown variety at Doho. Farmers mentioned that K5 is the variety that farmers at Doho originally grew before the current varieties. Only two farmers, out of the farmers

interviewed currently grows this variety. The farmer mentioned that this variety gives a good yield and is heavy when fertilizer is applied. However, farmers mentioned that this variety is not popular because it takes a long time to mature (i.e. six (6) months) (Table 6.5), and also the soils at Doho do not support its growth as it does well mostly in sandy soils. Nevertheless, the K5 variety is more favored on the Ugandan market because of its aromatic quality and taste (Ayiko, 2012). K5 also commands higher prices than other local varieties on the market (Table 6.4).

Table 6. 4 Lowland rice varieties grown in Doho

Variety	**Grain Quality**	**Yield** sack**/acre	**Yield (with RYMV*)** sack/acre	**Maturity period in months (days)**	**Plant height (cm)**	**RYMV resistance**
K98	Non-aromatic but tasty, shines	20		5		
Kaiso (K85)	Non-aromatic	20	6	5	90	weak
WITA 9	Non-aromatic	20	14	5(140 – 160)	85	strong
Super (K5)	Aromatic	15	2	6	140	weak

*****RYMV stands for Rice Yellow Mottle Virus. **1 sack equates to 100 kg of un-milled rice

6.4.3 Land preparation

One month before the rains start, farmers slash the stubble and stalks from the previous season and then perform the first ploughing while spreading the field residues across the farm. Bunds (or ridges), for retaining and draining water from the field, are then made around the plots. A little water is added to the farm to soften the ground before the first ploughing. After the first ploughing, water is applied to the field and let to stand to encourage the field residues to rot. Two weeks after this, the second ploughing is done during which the field residues are ploughed into the ground.

Slashing the stubble and stalks is done using a panga, whereas ploughing is done using a hand hoe or an ox-plough. The scheme cooperative owns a rotavator, as such farmers who can afford rent this rotavator at 35,000 UGX to perform the second ploughing. Bunds are made using a hand hoe and a spade. Farmers mostly perform the land preparation activities themselves with the help of their family members especially their children if they are available. Labour to hire for the various activities is always available in the community adjacent to the scheme. Slashing 0.25 acres of land goes for 7000 UGX, whereas ploughing goes for 25,000 UGX for 0.25 acres. In addition, some farmers form groups that can be hired for the various farm activities.

6.4.4 Seedbed preparation and Transplanting

All the varieties grown at Doho require seedbeds. After the first ploughing, a seedbed is prepared and enough water to moist the soil is added. Seeds are sold at the cooperative store at the scheme at 3000 UGX per kg. Farmers also keep some seed from the previous season if they want to grow

the previous season's variety but in a different plot. Varieties are rotated from season to season in a plot. Every farmer makes their own seedbed of area of 1 m × 10 m. If there are excess seedlings, farmers sell them to other farmers in the scheme. Sowing in the seedbed is carried out through broadcasting the seeds.

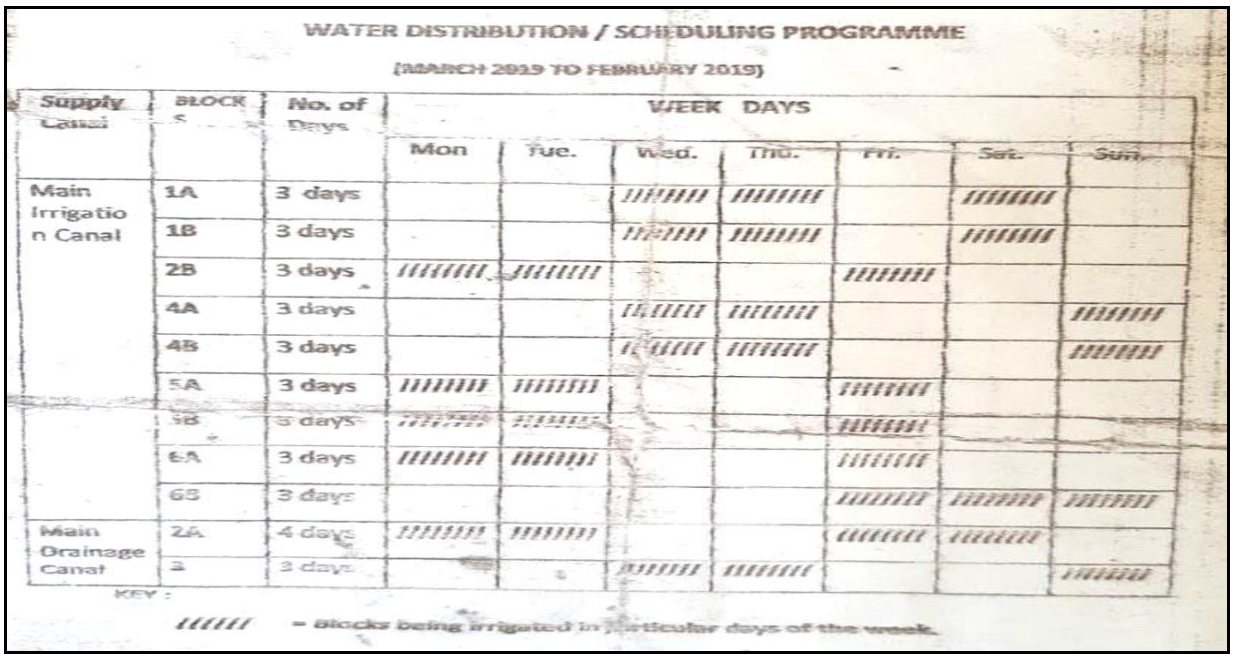
About two (2) weeks later, after the seedlings have germinated to a height of about 10 cm, water is applied to the seedbed; care is taken not to submerge the seedlings. This water level in the seedbed is maintained until when the second field ploughing is to be done. At the time of the second ploughing, the level of water is released from the field to allow for ploughing to occur, after which water is re-applied. Field levelling is done before transplanting. Seedlings are transplanted when they are about 5 inches tall or 21 to 30 days after sowing for all other varieties and 21 to 25 days after sowing for WITA 9. The seedlings are transplanted at plant spacings of 6 × 9 to 12 inches for all the other varieties and 6 × 12 inches for WITA 9. Transplanting is done manually. At transplanting, water is removed from the field for a week, although now and then a little water is added to avoid snails from attacking the rice transplants.

6.4.5 Water management in the scheme

When water is applied and how much water to apply purely depends on farmers' experiences. A week after transplanting little water is maintained in the field to aid tillering for 14 days. More water is added for another 7 days. Then, for 7 to 10 days, water is released from the field. After that, at about 40 days from the transplanting date, the field is continuous flooded until about 7 to 10 days before harvesting. Farmers mentioned that the second season is drier, and that the flow in the river significantly decreases reducing the amount of water that farmers receive in their fields. The reservoir water can only supply water to the scheme for 14 days. Thus, farmers face some extent of water scarcity especially during the second season. However, when the water in the river is ample, there is always water following in the canals even when it is not needed. Nevertheless, farmers mentioned that even during periods of reduced water supply, there is always equitable distribution of the available water. The main and secondary canals in Doho are not lined. Over time, scouring has deepened and widened, especially the main canal. Water losses due to seepage are considerable in these canals.

Doho rice irrigation scheme has a Water Users' Cooperative Society that was established when the government of Uganda handed over the scheme to farmers after rehabilitation. The cooperative comprises of nine (9) executive members headed by a chairman; three (3) of the nine positions are held by women. The cooperative works with different stakeholders including the sub-county and district staff, Ministry of Water and Environment (MWE) and Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) to coordinate and supervise activities on the scheme. Among other roles, the cooperative oversees allocation of water to all fields in the scheme. Every season, the cooperative draws up a schedule of distribution of water to the various blocks in the scheme. One such schedule is as shown in Figure 6.8. The cooperative is also in charge of maintenance of irrigation infrastructure including the headworks, canals, check gates, reservoir, and the scheme roads. Each farmer in the scheme is required to pay 100,000 UGX per year to the cooperative, and that money is used to operate and carry out maintenance works in the scheme. The scheme has an excavator given to it by the government to be used for maintenance works. The Water Users' Executive sits regularly to identify works that need to be

done in the scheme.mThere is no gauge at the main diversion point to the scheme from River Manafwa, as such the amount of water the scheme uses is not quantified.



WATER DISTRIBUTION / SCHEDULING PROGRAMME

(MARCH 2019 TO FEBRUARY 2019)

Supply Canal	BLOCKS	No. of Days	WEEK DAYS						
			Mon	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Main Irrigation Canal	1A	3 days			////////	////////		////////	
	1B	3 days			////////	////////		////////	
	2B	3 days	////////	////////			////////		
	4A	3 days			////////	////////			////////
	4B	3 days			////////	////////			////////
	5A	3 days	////////	////////			////////		
	5B	3 days	////////	////////			////////		
	6A	3 days	////////	////////			////////		
	6B	3 days					////////	////////	////////
Main Drainage Canal	2A	4 days	////////	////////			////////	////////	
	3	3 days			////////	////////			////////

KEY :

//////// = Blocks being irrigated in particular days of the week.

Figure 6. 8 Water distribution schedule for Doho

6.4.6 Weed, pest diseases and soil fertility management

When the fields are flooded, weeds are suppressed. Weeding is therefore minimal in basin irrigation. Farmers mentioned that they weed only once in a season; between 21 to 30 days after transplanting. Weeding is done by hand. Like all other farm activities, weeding is carried out by the farmer and his family members. Farmers in Doho do not use herbicides at all.

Several diseases attack the rice crop. Farmers mentioned that they normally go to veterinary shops in the trading centre adjacent to the scheme for remedies. Rats are very problematic; they eat rice as it grows in the field. Snails are also as problematic, if not controlled, they can cut the stalks of rice plants of entire fields. After grains start forming, birds love feeding on these grains. Someone must be in the field the whole day to scare off these birds because scarecrows do not work sometimes as the birds get used to them.

For most of the farmers interviewed, the crop residues ploughed into the soil during the second ploughing are the only kind of fertilizer they apply to their fields. Farmers mentioned that from their experience, fields that are flooded continuously do not need much fertilizers. That when fertilizer use is not regulated, it leads to overgrowth of the rice plants leading to their lodging after grains start to form. During windy conditions, most of these plants are lost causing losses to farmers. However, when fields are somewhat raised and they do not get flooded quite well, they then need to receive more fertilizer. For the few farmers that apply inorganic fertilizers, they apply Diammonium phosphate (DAP), UREA and NPK. DAP is applied at transplanting because it causes faster rooting of the transplants. UREA is applied in quantities of 5 to 8 Kg per 0.25 acre three (3) times in two-week intervals after transplanting. UREA, DAP, and NPK cost

2200, 2500 and 2500 UGX per Kg, respectively. Although several farmers mentioned keeping a few numbers of livestock, animal manure is not applied to the rice fields at all by Doho farmers. They use the animal manure on other crops that farmers grow outside of the scheme.

6.4.7 Harvesting and postharvest handling

When the rice crop matures, farmers cut the plants using a hand-held sickle and placing them on a tarpaulin. The cut rice plants are then threshed i.e. the grain is removed from the chaff attached to it by hitting the cut plants with sticks while on the tarpaulin and on the ground. After threshing, the grain is separated from the chaff through winnowing, put in bags and carried by hired labour to the road side. A vehicle is then hired to transport the bags of paddy to the drying yard at the mill where milling will be done. The millers offer the space and the tarpaulins on which the rice is dried under the sun for free and storage of the paddy and in exchange, the farmer pays the miller for milling.

Although done at the mill, the farmer is responsible for drying their rice. When there are clear skies, drying takes 3 days. When dry, the rice paddy is again winnowed to remove any chaff from the grains. The dried paddy is then packed in bags and stored at the mill until when the farmer will find a buyer for their rice, then the paddy will be milled and sold to the buyer. Farmers at Doho sell only milled rice. Millers charge 100 UGX per Kg of paddy rice milled. Farmers mentioned that a 100 Kg bag of unmilled paddy gives about 65 Kg of milled rice. Farmers also mentioned that the rice they grow is almost purely for sell (about 90%). The 10% is used for home consumption and for seed. The current price of milled rice at Doho irrigation scheme ranges from 2200 to 2400 UGX per kg. The price range is mostly due to the quality of rice being sold (i.e. percentage of broken grains and amount of sorting that would need to be done to remove stones and chaff before cooking) and the variety of rice being sold. Milled rice with more whole grains than broken grains, and with less or no stones and chaff in it carries a slightly higher price. Also, varieties like WITA 9 which ‘shine’ when processed also fetch a slightly higher price. The husks and bran, the by-products of milling rice are either used by the communities as animal feed and as fuel for cooking or sold off to people that come around to buy them and take them to Kenya. Farmers and millers in Doho mentioned that the husks and bran taken to Kenya are used to make plywood and cooking spices respectively.

Millers mentioned that although postharvest handling to some extent affects the quality of milled rice, the agronomic practices that the rice crop is subjected to during its various growth stages will affect especially the heaviness of the grains and strength of the grains such that they are not easily broken during processing. Nevertheless, the rudimentary methods of threshing and drying the paddy, and the low-quality mills available also affect the quality of milled rice. Hitting the harvested rice with sticks during threshing might weaken the grains. The rate of drying and the extent of drying cannot be controlled when the rice is dried under the sun. Also, the low-quality mills might not only break the rice grains while milling, but they cannot destone or grade (into whole grains, broken grains, polished, and unpolished).

6.4.8 Rice markets

Farmers in Doho rice irrigation scheme only sell their rice after it has been milled. Farmers individually supply to both retail and wholesale shops around the scheme. Also, rice buyers from nearby towns, and those from mostly Kampala and Mbale come and buy rice directly from the farmers.

6.4.9 Rice in crop rotation and Integration of fodder and rice production

Doho irrigation scheme is purely a paddy rice growing scheme. Rice is not rotated with other crops. As mentioned earlier, it is only the varieties of rice that are rotated season after season. Farmers interviewed in Doho rice irrigation scheme mentioned that they keep livestock including cattle, goats, pigs, poultry, etc. However they do not bring or allow the animals into the scheme to graze, and neither do they use animal waste as manure in the rice fields although they use the manure in their other fields outside of the scheme where they grow several other crops. Within the scheme, farmers may cut rice crop residues and the grass on the ridges/bunds and carry it to their animals to feed. The husks after milling rice are also used to feed animals.

6.4.10 Gender dimensions in rice production in Uganda

The rice sub-sector is a major source of livelihood to women and youths in the rice growing areas. Women and youth are heavily involved in all activities along the rice value chain as both family labour and hired labour (Key informant interviews, 2020). Activities like planting, transplanting, weeding, and cleaning and drying of rice are mainly done by women. Youths are involved in a whole range of activities including land preparation, application of fertilizers and other agro-chemicals, bird scaring, rice threshing, transportation of threshed rice, loading and offloading of rice bags, cleaning mill premises, weighing, packaging and retailing of rice (Key informant interviews, 2020; MAAIF, 2019).

6.5 Challenges in rice production in Uganda

Several challenges were highlighted by the stakeholders interviewed. Some of these challenges include:

- ✓ Small holder farmers grow local varieties that can hardly compete with imported varieties on the national urban markets and international markets
- ✓ Failure for the government to enforce policies on the quality of agro-chemicals leading to markets being flooded with sub-standard pesticides and herbicides
- ✓ Most of the rice growing activities including land preparation, planting, weeding, harvesting, threshing, drying, are manual leading to drudgery and low quality of activities preformed on-farm and off-farm. Where machinery is used like in milling, low quality mills are used, and thus low-quality rice is produced i.e. rice that is broken and that has chaff and stones in it
- ✓ Poor rice storage facilities and poor rice drying facilities and materials
- ✓ Lack of clarity and direction on the government's stance on rice cultivation in wetlands, affecting plans of increase in rice production areas

- ✓ Inconsistencies in policy implementations such as the tax waivers and exemptions allowed for rice millers to import rice whose quality and price, the local producers cannot compete with
- ✓ The fields are cultivated year after year, season after season with minimal fertilizer use. Soil fertility issues might be some of the factors affecting intensifying rice production
- ✓ Levelling in most of the paddy rice fields is not adequate

6.6 Identified rice intensification options

The following have been identified as options to intensify rice production in the country since increasing rice production through utilizing more wetland areas might not be possible any more following the president's directives:

- ✓ Promotion of use of improved seeds and seed varieties that can compete favorably with imported rice varieties and other rice varieties on the regional and international markets
- ✓ Carrying out fertilizer trials on various rice varieties grown under various conditions in order to provide guidelines to farmers on which fertilizers to apply and when in order to maximize yields
- ✓ Mechanization of the various rice production activities including land preparation, planting, weeding, harvesting, threshing, and drying. Appropriate technologies whose parts can be sourced locally should be promoted. Local artisans should be trained in repair and maintenance of these technologies
- ✓ Carrying out water saving options at farm scale, not only for water savings but also for boosting crop yields
- ✓ Carrying out sustainable catchment management interventions in catchments of rice growing areas such that flooding, and siltation of rivers and canals can be lessened
- ✓ Investing in more water storage structures to make more water for use in drier periods
- ✓ Gauging of rivers and canals supplying irrigation schemes for better planning and management of water resources
- ✓ Lining primary and secondary canals and levelling fields for irrigation for better on-farm water management.

6.7 Stakeholders in the rice sub-sector

These include rice farmers, rice millers, traders (including retailers, wholesalers, importers and exporters), consumers, government agencies, private sector associations and non-governmental organizations supporting the rice sub-sector in Uganda. These include:

Table 6.5 Stakeholders in the rice sub-sector

Stakeholder	Roles and responsibilities	Contacts
Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)	Mandated to formulate and review national policies, plans, legislation, standards and programmes relating to the agricultural sector as well as control and manage crop and animal epidemic diseases affecting production. MAAIF is	- Alex Lwakuba, Commissioner Crop Production, alwakuba@gmail.com, +256-772-402380 - Ogwal Emmanuel, Senior Agricultural Officer and Rice Desk Officer, ogwalemmanuel22000@gmail.com, +256-772-871650 - Allan Guma, Rice Program Officer and

	also mandated to support, promote, and guide the production of crops, livestock and fish in order to ensure improved quality and increased quantity of agricultural produce and products for local consumption, food security and export.	Rice Desk Officer, Agriculture Cluster Development Project (ACDP), +256-775-100513 - Imelda Kanzomba, Senior Agricultural Officer – Farmland Planning and Office in Charge of Olweny rice irrigation scheme, ikanzomba@gmail.com, +256-704-577312 - Wilberforce Sagula, Technical Officer at Doho irrigation scheme, hwsagula@gmail.com, +256-782-653156
Ministry of Water and Environment (MWE)	Responsible for water for production infrastructure development. One of its mandates is to plan and establish irrigation schemes, in addition, to providing on-job training of key staff in all aspects of the scheme involving planning, design, supervision and post construction management set-up.	- Dr. Callist Tindimugaya, Commissioner, Water Resources Planning and Regulation, callist_tindimugaya@yahoo.co.uk, +256-772-521413 - Juma Nakendo Kirunda, Senior Sociologist in the Directorate of Water Resources Management, juma.nakendo@mwe.go.ug, - Rogers Masaba, Deputy Manager, Water for Production Region Centre – East, msb2rogers@gmail.com, +256-783-154345
National Agricultural Research Organization (NARO) – National Crops Resources Research Institute (NaCRRI), Namulonge	Responsible for rice seed research including rice varietal development, trial and dissemination. NaCRRI also produces foundation seed for seed multiplication.	- Dr Jimmy Lamo, Rice breeder and Program Leader Cereals (Rice and Maize), jlamoayo@gmail.com, +256 -772-342757 - Simon Alibu, Agronomist, simoalibu@gmail.com, +256-772-397674
NARO – Agricultural Engineering and Appropriate Technology Research Center (AEATREC), Namalere	AEATREC is an engineering research centre under the National Agricultural Research Laboratories (NARL) of NARO responsible for generation, adaptation and dissemination of appropriate agricultural engineering technologies to meet farmer and market demands; training of farmers, agro-processors and other users on O&M of machinery and other technologies; training of- and provision of back-up services to rural artisans, technicians and private fabricators; and advisory and consultancy services in Agricultural and rural engineering.	- Eng. Dr. Florence Kiyimba Lubwama, Senior Research Officer, florencekiyimba@gmail.com, +256-772-509892 - Eng. Charles Mutumba, Research Officer, mutumbacarlos@gmail.com
National	NEMA is a semi-autonomous	- Arnold Ayazika Waiswa, Director,

Environment Management Authority (NEMA)	institution responsible for coordinating, monitoring, regulating and supervising environmental management in the country.	Environmental Monitoring & Compliance, wayazika@nema.go.ug, +256-772-471139 - Dr. Jerome Lugumira, Natural Resources Manager (Soils & Land Use), jerome.lugumira@nema.go.ug, +256-757-763956
RICE ASSOCIATION OF UGANDA (RAU)	RAU is a national organization that was formed by rice farmers in order to promote and safeguard the domestic rice sector in Uganda	- Dr. John Daniel, Chairman and Head of Farming and Research at Kibimba Ltd, - Racheal Mbabazi, Board member - Coordinator of Northern Chapter – Bongomin Andrew Okot - Chapter Coordinator for Eastern Uganda – Ahmed Naleba
Rice Business Sector Association	The association comprises of local rice dealers comprising of farmers, producers, and processors.	- Isaac Kashaija, Chairperson,
NGOs: - Japan International Cooperation Agency (JICA)	JICA conducts and also supports several initiatives, projects and research studies on several aspects aimed at enhancing of rice production in Uganda, and development of irrigation infrastructure, policies and strategies in Uganda.	- Dr. Jiro Nozaka, Chief Advisor, Promotion of Rice Development Project Phase 2 (PRiDe II), nozakaj@gmail.com, +256-779-184526 - Takeki Shimawaki, In-charge – Agriculture Project Advisor, shimawaki.takeki@jica.go.jp - Paul Lubega, Programme Officer, lubegapauleta20@gmail.com, +256-773-253894
- AfricaRice	AfricaRice is one of 15 international agricultural research centers of CGIAR. It is also an intergovernmental association of African member countries and Center of Excellence for locally tailored rice research for development and capacity building in a number of African countries including Uganda.	- Dr. Edgar Twine, Associate Principal Scientist – Marketing and Rice Value Chain Expert, E.Twine@cgiar.org, +256-775-914 074
- Rikolto International s.o.n	Rikolto (formerly VECO/Vredeseilanden) is an international NGO aim to contribute to sustainable rice sector transformation at national, regional and global level, in order to: provide safe, healthy, sustainable and quality rice to consumers; generate decent profits and jobs for all actors along the value chain, especially for smallholder farmers (men, women and youth); and reduce	- John Ereng, Rice Coordinator, john.ereng@rikolto.org

	the environmental impact of rice cultivation and to preserve the environment for future generations	
PROCESSORS: - The Rice Millers Council of Uganda Limited	The council is a private sector-led organization that encompasses the large- and small-scale millers, the large-scale rice growers as well as the representatives of smallholder rice farmers across the country. It's objective is to promote and protect the rice trade, market and processing industry and to consider and resolve matters, issues, problems and questions connected with the trade, commerce and value addition faced by the rice sector.	- Amb. Philip Idro, Chairperson and Managing Director of Upland Rice Millers Co. Ltd, +256-788-052803
RICE MILLERS	Responsible for milling rice	- Muzamiru Mwima, Nampologoma trading center, +256-772-645606 - Hamidu Wambasa, Nampologoma trading center, +256-782-643455
RICE FARMERS (all from Doho irrigation scheme)	They grow rice for sell	- Wasige Ayubu, Chairperson Water Users' Cooperative Society, +256-0771-496794 - Mwima Yolamu, Vice Chairperson - Isaac Kabasa, General Secretary - Adam Kanene, Board Member - James Nagolo, Board Member - Edinari Mulago, Board Member - Janet Hamayo, +256-773-622231 - Mubejja Rehema Nakalema, +256-787-429756 - Ali Wadidi, +256-784-828966 - Benya Watatya, +256-758-701218 - Hasuli Bumali, +256-788-944991 - Edith Namemba, +256-782-222737 - Muhamad Ndowori - Bulaila Higenyi, +256-783-367217 - Dawson Haperi, +256-704-242319 - Charles Nadide - Alizephan Gonasa - Christiano Ekisa, +256-770-740018 - Wilson Haperi - Betty Sabano, +256-702-703357 - Wilson Were, +256-777-769503 - Jackline Mulongo , +256-777-278627

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6.9 Appendix: Rice demand, imports, exports, and harvested area harvested and production in Uganda, 1961-2019

Appendix Table 1: Rice demand, imports and exports, and paddy rice area harvested, production and yield over the years in Uganda. (Source: FAO, 2020*; MAAIF, 2019)

Year	Domestic supply quantity (milled equivalent) (000' tonnes)	Paddy rice production (000' tonnes)	Paddy rice area harvested (ha)	Paddy rice yield (kg/ha)	Rice imports (000' tonnes)	Rice exports (000' tonnes)	Net imports (000' tonnes)
1961	9	3.2	2630	1216.7	6.56		
1962	8	4.0	3197	1251.2	5.11		
1963	6	1.7	1376	1199.1	4.83	0.03	4.8
1964	8	2.3	1983	1159.9	6.35	0.06	6.29
1965	13	4.8	4000	1187.5	9.92	0.49	9.43
1966	13	6.2	3000	2066	8.78	0.3	8.48
1967	15	7.8	6000	1304	10.18	0.36	9.82
1968	3	2.9	5000	573.6	1.87	0.41	1.46
1969	9	4.8	7000	681	5.96	0.3	5.66
1970	12	11.4	15621	732.3	4.03	0.18	3.85
1971	19	22.0	24000	916.7	4.13		
1972	16	15.7	17900	877.1	5.34		
1973	8	8.7	9800	887.8	1.78		
1974	14	15.0	17300	867.1	3.6		
1975	16	16.0	17900	893.9	4.99		
1976	21	29.0	24409	1188.1	2		
1977	14	21.0	19600	1071.4			
1978	17	25.7	24400	1053.3			
1979	20	15.0	12000	1250	10		
1980	27	17.0	11000	1545.5	15		
1981	19	15.0	12000	1250	8.8		
1982	18	19.0	15000	1266.7	5.2		
1983	21	22.0	17000	1294.1	6		
1984	21	20.0	17000	1176.5	7.5		
1985	19	19.0	14000	1357.1	6		
1986	20	21.0	19000	1105.3	6		
1987	19	20.0	16000	1250	6		
1988	15	23.0	17000	1352.9			

1989	36	45.0	32000	1406.3	6.1		
1990	36	54.0	39000	1384.6			
1991	41	61.0	45000	1355.6	0.41		
1992	46	68.0	50000	1360	0.83		
1993	51	74.0	53000	1396.2	2.08		
1994	59	77.0	55000	1400	8.06	0.09	7.97
1995	60	77.0	55000	1400	8.83	0.54	8.29
1996	67	82.0	58000	1413.8	12.52	0.12	12.4
1997	84	80.0	60000	1333.3	32.5	1.69	30.81
1998	92	90.0	64000	1406.3	53.68	1.37	52.31
1999	123	95.0	68000	1397.1	39.74	0.23	39.51
2000	123	109.0	72000	1513.9	45	0	45
2001	98	114.0	76000	1500	45	0	45
2002	122	120.0	80000	1500	45	0	45
2003	136	132.0	86000	1534.9	60	5	55
2004	135	121.0	93000	1301.1	60	10	50
2005	155	153.0	102000	1500	50	15	35
2006	138	154.0	113000	1362.8	65	20	45
2007	158	162.0	119000	1361.3	65	25	40
2008	157	177.9	128000	1389.5	75	35	40
2009	179	205.8	86000	2392.6	80	35	45
2010	183	218.1	87000	2507	80	40	40
2011	210	233.0	90000	2588.9	125	60	65
2012	204	212.0	92000	2304.3	120	70	50
2013	188	214.0	93000	2301.1	120	40	80
2014	196.7	237.0	94800	2494.7	120	40	80
2015	300	237.0	95277	2487.6	120	40	80
2016	255	246.8	97073	2542.6	115	40	75
2017	414	262.6	97505	2693.5	110	40	70
2018	223.4	246.5	96210	2530	125	40	85
2019					125	30	95

* Most of the data are FAO estimates because the official national data and statistics are limited. Where national data was found, the FAO estimate was substituted for the official national statistic.

Appendix 1: ScaleWAYS workshop: List of participants

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26th – 28th February, 2020, Liaco Hotel, Entebbe, Uganda

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