NAFAKA – Tanzania Project

The rice value chain in Morogoro, Tanzania: Current status and strategies for development

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Summary

Tanzania is one of the largest rice producers and consumers in East Africa. Demand for rice is increasing as a result of urbanisation and changes in consumer preferences. Rice area is increasing, but not production and productivity. This study aimed to identify bottlenecks in the rice value chain in Morogoro region, as a basis for developing strategies to strengthen rice production and marketing.

The study was conducted under the NAFAKA project, which is part of the Feed The Future (FTF) program funded by USAID.

The Morogoro region has both rain-fed and irrigated rice systems. Production in Kilombero district is largely rain-fed. Kilombero has potential for rice expansion, with considerable untapped natural resources. However, frequent droughts in the past decade have pushed rice yields to below two tons per hectare. With rainfall continuing to decline, there is need for greater research efforts to develop drought-resistant high-yielding varieties.

Farmers in Morogoro generally follow poor agronomic practices. They are not aware of many improved practices such as regular plowing, levelling, bunding, harrowing, timely sowing, harvesting after maturity etc. These practices will help to conserve rainwater and retain soil moisture for longer, preventing moisture stress. Levelling is essential in paddy, because undulating fields will lead to uneven growth, gaps and low yield. It is important to educate farmers on best agronomic practices for paddy cultivation.

The use and availability of quality seed is very limited. Farmers use very high seed rates for sowing, increasing production cost and adding to the high demand for seed. It is important to introduce technologies such as direct seeding. Various options are available: using a seed drill in dry conditions, or a seed drum in puddled conditions, the SRI method for puddle conditions, direct seeding by dibbling (similar to SRI except that it involves seeding rather than transplanting). These methods reduce seed requirements by 25-30% and in SRI by 50-60%. They ensure high returns with low investment.

Higher yielding varieties are also needed. Few such varieties are commercially available except for SARRO-5 and Nerica-1. The former is a semi aromatic type that is gradually gaining acceptance. Tanzanians prefer aromatic to non aromatic rice; more than 90% of area is under aromatic types. There are no aromatic varieties officially released in Tanzania, but aromatic types brought from India have been cultivated for many decades and are preferred by consumers. National research institutes should maintain these varieties, and conduct selections for improvement and use in breeding programs.

The use of improved varieties is negligible, because of poor farmer knowledge, non availability of seed at village level, poor roads and other factors. It is essential to create awareness about the benefits of new varieties and quality certified seeds, through training programs, demonstrations and farmer field schools. There are no seed companies involved in rice multiplication except for Tanseed International Ltd. which began rice activities two years ago in collaboration with NAFAKA. The company is making progress but needs to improve seed production method, harvesting and processing methods and strengthen its distribution network in the region. There is a need to develop varieties with drought resistance followed by aromatic types. The researchers are working towards this goal but no major breakthroughs have been achieved. NAFAKA can help these institutes access germplasm from international organizations and research institutes.

The use of fertilizer is very limited in the rain-fed paddy belt. Many farmers use no fertilizers due to non availability at village level, poor purchasing power, lack of credit, small holding size, poor roads

and lack of understanding about fertilizer use. Very few use even one bag of DAP or urea per acre in the entire season. Rural youth and farmers associations can be encouraged to set up agro-dealer shops to supply rice growers. Farmers require training on fertilizer rates and application methods.

Weed management is very poor. There are a number of grassy weeds that compete vigorously with rice. Educating farmers on the use of herbicides and integrated weed management (IWM) could improve weed control.

Knowledge about rice pests and diseases is very poor, and limited largely to researchers. Rice Yellow Mottle Virus (RYMV) is the most important disease. Leaf blast, bacterial blight, sheath blight, neck blast, leaf spot were also recorded during this study. Insect pests included stem borer, hoppers, leaf folder, hispa, cutworms and termites. It is essential to educate farmers, agro-dealers, seed growers and extension staff on the different pests and diseases affecting paddy, their identification and how to control them. Some pesticides and fungicides are available in the market but very few farmers use these – and those who do, do not use scientific methods. A small pocket diary or booklet on pest and disease management would be of great value to paddy farmers

All these factors – poor quality seeds, poor cultivation practices, low fertilizer use, moisture stress, pest and diseases – reduce tillering ability in paddy. This leads to chaffy and incompletely filled grains. Harvesting methods in this region are very poor. They further reducing the quality of grains and seeds, with a high percentage of grain breakage. Farner training, and introduction of minim combine harvesters or multigrain harvesters will ease the harvesting problem and improve the quality of rice grain as well as seeds.

Poor roads and transportation facilities are limiting paddy trade in Morogoro, and providing farmers with no incentive to increase production. Credit availability is a concern of every smallholder. Banks should be encouraged to open micro-credit facilities or mobile banking services in remote places.

In Mvomero, the other district where NAFAKA is active, rice is grown under irrigation. The district has a large number of paddy grain growers and seed producers, and fewer production constraints and higher yields compared to rain-fed areas. Problems relating to quality seeds, poor agronomic practices, weed management, fertilizer use, and pest and disease management are similar to rain-fed situations but less severe. Fertilizer use is higher than in rain-fed areas but still not adequate.

At least 10 improved varieties have been released by KATRIN based at Ifakara. But only one variety TXD 306 (SARRO-5) has become popular; followed by Nerica 1. There are other good varieties released and also those developed by IRRI. Support from researchers, developmental agencies, farmer associations, extension agencies and private seed companies is necessary to popularise these varieties and ensure seed is available. Greater efforts are also needed to introduce suitable varieties through demonstrations at different locations. Farmer-participatory varietal selection should be used to identify varieties that best meet the preferences of farmers, millers and traders. For example, although SARRO-5 and Nerica-1 are available, many farmers prefer to use their own aromatic-type varieties. No seed multiplication of these varieties takes place; farmers simply use grain from the previous season as seed. Research institutes should consider this fact while developing and releasing a new variety.

More attention is needed to establish agro-dealers at village level and encourage their interest in marketing seed and other inputs for paddy cultivation. Educated rural youth, rice traders, and millers could also invest in opening agro-dealer shops. There is need for warehouses at village level. Farmers do not store paddy after harvest, but sell immediately to nearby traders or millers. Only a few large farmers wait until they get a better price. This situation can be resolved only by improving storage facilities.

Tanseed International Ltd. is working with NAFAKA to strengthen the rice seed chain in Morogoro. It is the only company operating in the region. Tanseed produces its seed on farmers' fields under a

contract seed production program. This year, it is undertaking seed production on more than 150 acres. To ensure seed quality, the company requires a harvesting machine and seed processing plant for rice. It may be worthwhile to consider partial project support for acquiring this equipment. KPL is the only private company producing rice seed, not for commercial sale but for its own rice farms and contract growers.

Overall there is a need to introduce and popularize improved technologies at each stage of rice cultivation. Training of seed growers, agro-dealers, traders and millers is essential. A study tour outside Tanzania could be organised for progressive farmers and seed company staff to learn about the latest technologies available for paddy grain and seed production.

Introduction

Rice is the second most important food crop in Tanzania after maize. Rice production and area are increasing in parallel with consumption, but demand remains higher than production and imports are needed. Based on 2012 production figures released by the government of Tanzania, paddy production stood at 1.12 million tonnes (733 000 tonnes, milled basis). This is 23 percent below the already poor 2011 outcome and the smallest harvest since 2004. The sharp contraction was due to poorly distributed rainfall, which delayed planting and negatively impacted main paddy crops harvested between June and July. The preference for rice over maize is rapidly increasing in urban areas. Unless production constraints are resolved, domestic production will remain insufficient to meet the increasing demand. There is a need for a technological transformation from conventional methods to mechanized and advanced practices of paddy cultivation.

The present study covered both rainfed and irrigated rice cultivation in Morogoro region. It assessed the current situation in order to understand the constraints faced by growers, traders, millers and consumers and subsequently to develop recommendations to overcome the challenges.

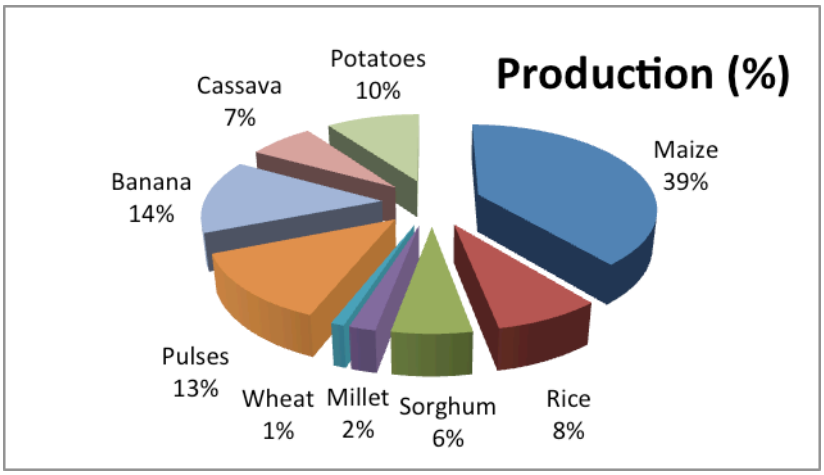


Figure 1. Production share of different field crops in Tanzania

Figure 2. Crop zones in Tanzania (Morogoro is a potential zone of rice)

Objectives of the study

The study was undertaken with the following objectives:

- Identify potential scope for increasing the volume of rice business in Morogoro
- Identify constraints faced by rainfed and irrigated paddy growers, traders, millers, processors and other stakeholders involved in rice value chain
- Assess the status of paddy seed availability, production, processing, marketing and scope for increasing the volume of seed trade
- Explore the feasibility of establishing collaboration between national and international research organizations for germplasm exchange and breeding programs
- Identify gaps in agronomic practices in order to improve yield and quality
- Understand the farmer's knowledge of, and ability to control, pests, diseases, nutrients and weed management in paddy
- Identify the opportunities for farmer-participatory seed production in paddy
- Understand the strengths and abilities of agro-dealers in meeting the requirements of paddy growers at village level
- Document the status of rice seed movement and scope for private players to participate in seed multiplication and marketing
- Identify methods for popularising the new varieties, agrochemicals and other technologies for paddy cultivation.

Methodology

- Field visits were conducted for both rain-fed and irrigated rice ecosystem at Kilombero and Mvomero districts, on farm situations were analysed and problems existing were recorded.
- Informal interactions were held with paddy growers, and field workers to discuss their experience, knowledge, constraints faced and approaches to solve them.
- Visits and interactions were also held with paddy traders, millers and local people on various factors associated with paddy trade, quality issues, milling, storage, transportation and rice market prices with trends at local and outside places.
- Agro-dealers were visited to understand their knowledge, service, inputs available and trend of business, to learn and plan different chemical inputs required for paddy cultivation.
- Meetings were held with researchers and technical staff from the department of agriculture to understand the present status and plans for improvement of the rice value chain.
- Discussions were held with seed company staff and seed growers to document current practices followed and future plans to expand or continue the venture.
- Inputs from all stakeholders were used to develop recommendations for promotion of a sustainable rice value chain.

Rice cultivation in rainfed areas

Rice in Tanzania is mainly grown rainfed. Morogoro is the second largest rice growing region in the country (12% of total production in Tanzania, 138,000 mt in 2011). It has both rain-fed and irrigated systems. Being the operational focus of NAFAKA for rice, both systems were extensively visited and studied to formulate plans for developmental activities to meet the objectives of the Feed The Future (FTF) program.

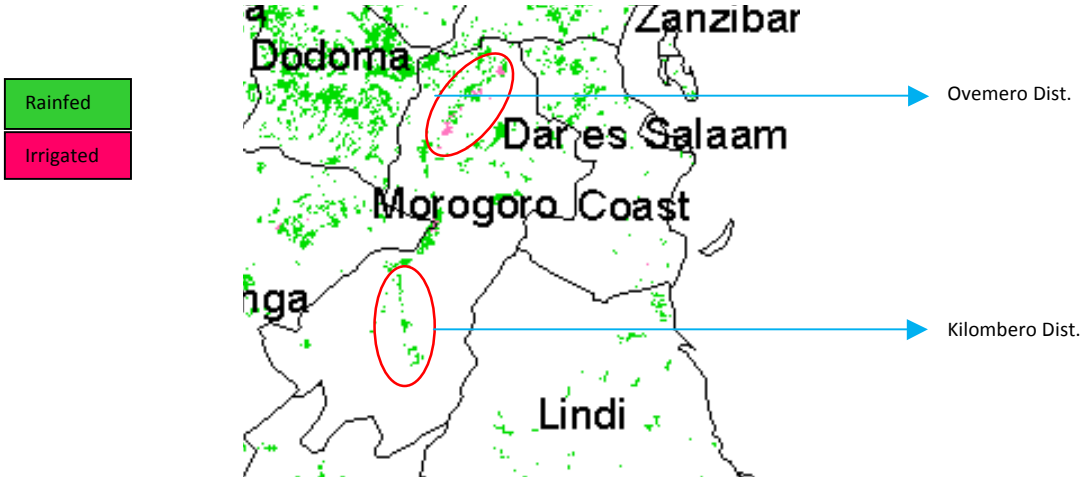


Figure 3. Kilombero and Ovemero districts in Morogoro

The region has around 250,000 smallholders producing rice and supplying to the largest rice market in Tanzania (Dar es Salaam market). It also has the largest commercial rice player in the country, Kilombero Plantation Limited (KPL) in Kilombero district. KPL is mainly doing rice production on its own farm and does contract farming with large paddy growers. But the major forces behind the rice economy are smallholders.

Kilombero district has most of its rice under rainfed cultivation. The area has some irrigation resources from the streams and rivers flowing through foothills of mountains spread across the district. But most of the irrigation is used for sugarcane, which is a major cash crop. This has left little scope for rice cultivation under irrigation. However, urbanisation, and income and population growth are increasing preference for rice in the daily diet; this has been a stimulating factor for increase in rice demand and area. The higher price compared to maize is attracting more farmers to take up rice. A small shift towards rice from sugarcane was also noted on the ground.

Rice cultivation in Kilombero begins with land preparation in November and December. Normally paddy cultivation starts with land preparations like plowing, hoeing and harrowing by bullock drawn implements. Sowing is mainly done by direct broadcasting to main field or dibbling. Occasionally transplanting is done where irrigation sources are assured like nearby streams and lakes. On an average 15 to 16 kg seed/acre is used for both transplanting and dibbling. For broadcasting seed rate goes up to 50 to 60 kg/acre. For weed management, herbicide (2,4-D) is sprayed after sowing followed by a hand weeding. Fertilizer application is very limited; most of the farmers use either urea or Diammonium Phosphate (DAP) 1 bag/acre (50kg). Those who are aware about the benefits of fertilizer use two bags, 50kg DAP at planting and 50kg urea 30 days after planting for transplanted paddy; otherwise for rain-fed rice only one bag of urea or DAP.

Diseases and pests are severe but not well managed. Those who had some training from developmental agencies (<5%) apply pesticide and fungicide sprays. Harvesting is done by sickles leaving behind the stubble. The straw with panicles is placed on a pre-cleaned ground or on a tarpaulin and threshed by beating with a wooden stick. Later the husk is removed by winnowing. The grains separated are packed in polythene bags and shipped to nearby markets or mills or sold to traders. Storage is rarely practiced. Instead, farmers sell immediately after harvest, for cash prices fixed by traders. Farmers face numerous constraints, which are leading to reduced yield and productivity per unit area.

Constraints identified and recommendations suggested for rainfed rice

Drought: Over the last half century the rainfall at Ifakara and in entire Kilombero district has reduced by more than 500 mm and its distribution over the season is also erratic. Reduced rainfall and rainwater conservation have caused decline of the ground water table and increased the frequency of drought during last decade. The already limited irrigation resources are gradually disappearing.

Table 1. Rainfall pattern at Ifakara (Kilombero District)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept.	Oct	Nov	Dec	Total
1961	154.0	143.0	47.0	311.0	124	55	75	7	37	187	253	475	1868
1971	135	93	239	282	131	26	40	0	3	18	25	100	1092
1981	209.9	145.2	222.7	366	129.1	54.5	-	3	2	47.7	15.1	157.1	1352.3
1991	177.6	23.3	265.9	520.5	152.1	10.3	29.8	0.1	16.6	6.7	55.4	185.1	1443.4
Rainfall pattern during the last decade at Ifakara (Kilombero district)													
2001	265.5	110.8	193.2	416.3	219.6	29	9	1.6	-	1.7	0	243.3	1490
2002	296	171.1	514.9	395.3	31.1	13.7	25.6	7.8	31.9	65.7	46.8	220.9	1820.8
2003	149.6	312.6	257.9	237.3	74.2	11.9	24	0	15.8	8.5	6.3	109.5	1207.6
2004	226.6	436.6	215.8	343.2	9.4	17.4	0	0.7	7.4	90.2	110.4	239.6	1697.3
2005	176.1	34.1	254	288.1	169.6	51.7	0	1.9	1.8	2.2	52.9	2.5	1034.9
2006	71.8	253.8	124.8	526.1	97.6	87.4	18.4	58.8	28.4	64.9	126.5	499.8	1958.3
2007	102.8	114	361.3	200.5	90.1	31.2	2.5	67.9	23.4	36.6	78.3	98.9	1207.5
2008	86.9	282	371.2	413	23.3	8.9	1.2	3.1	3.6	31.9	133.5	71.4	1430.0
2009	101.2	215.5	183.7	183.9	101	9.1	0	0.5	0	1.4	16.9	140.3	953.5
2010	211.6	59	239.6	234.8	53.4	31.2	0.4	4.9	1.6	0	16.9	134.9	988.3
2011	66.7	367.3	351.7	236.5	153.8	17.3	0.4	1.3	51.6	53.5	42.9	-	1343.0
	Rice growing period (RGP)											RGP	

It is essential to disseminate long term water conservation measures for this traditional paddy growing tract. *Implementation of watershed measures; erection of tanks at village level, farm ponds at individual farm level and check dams across the streams and water flows from large catchment areas would help in harvesting the rainwater and using it for crop cultivation*. Implementation of watershed activities should be considered seriously both at local and national level by all agencies working on rice value chain. *Simultaneously efforts should also be made by research stations to develop drought resistant varieties and by extension agencies to promote these varieties.*

Many farmers start paddy sowing very late and extend the crop maturity till end-May or June and harvesting till end-June. This often exposes the paddy to extreme drought and water stress. *Earlier sowing in December will ensure assured water availability for the next four months which usually receive near normal rainfall. This will enable the crop to complete its growth cycle. Varieties maturing in 110 days to 130 days are most suitable to avoid or escape from drought starting from end-May. Farmers should be educated about this simple agronomic practice.*

Suitable paddy cultivation calendar for rainfed areas

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept.	Oct	Nov	Dec
	Rice cultivation calendar											
Operations												
	Monthly operations to be carried out											
	Sowing	Weeding			Harvesting Threshing					Land preparation		Sowing
	Fertilizer Application Pest and disease management			A relay crop (short duration) can be introduced to grow on left over soil moisture to get additional benefit (Preferably legumes) during May end to August								
Crucial stages	Tillering, flowering & Seed setting (Assured yield)			Planting/ sowing must be done during December or before first week of January. Delayed sowing lead to water stress during flowering and seed filling, hence yield may get reduced by 10 to 15%.								Germination and seedling establishment

Poor land levelling, plowing and bunding: Paddy growers in rainfed areas are not properly levelling their lands. Most farmers have brought in new areas under paddy cultivation which are undulating without any borders. This leads to uneven moisture distribution leading to gaps and dwarf growth. *Land levelling ensures the availability of soil moisture uniformly across the field. Deep plowing the plots once during summer improves soil status, moisture holding capacity and reduces the pest and disease population. Harrowing to fine tilth helps in proper placement of seeds while sowing. Bunding helps in-situ conservation of rainwater, reduces loss through runoff, and prevents losses of fertilizer and topsoil. In the event of poor rainfall bunded plots could be irrigated.*

Plot without any bunding and levelling

Plot with bunding to conserve water

Non uniform distribution of water in main field

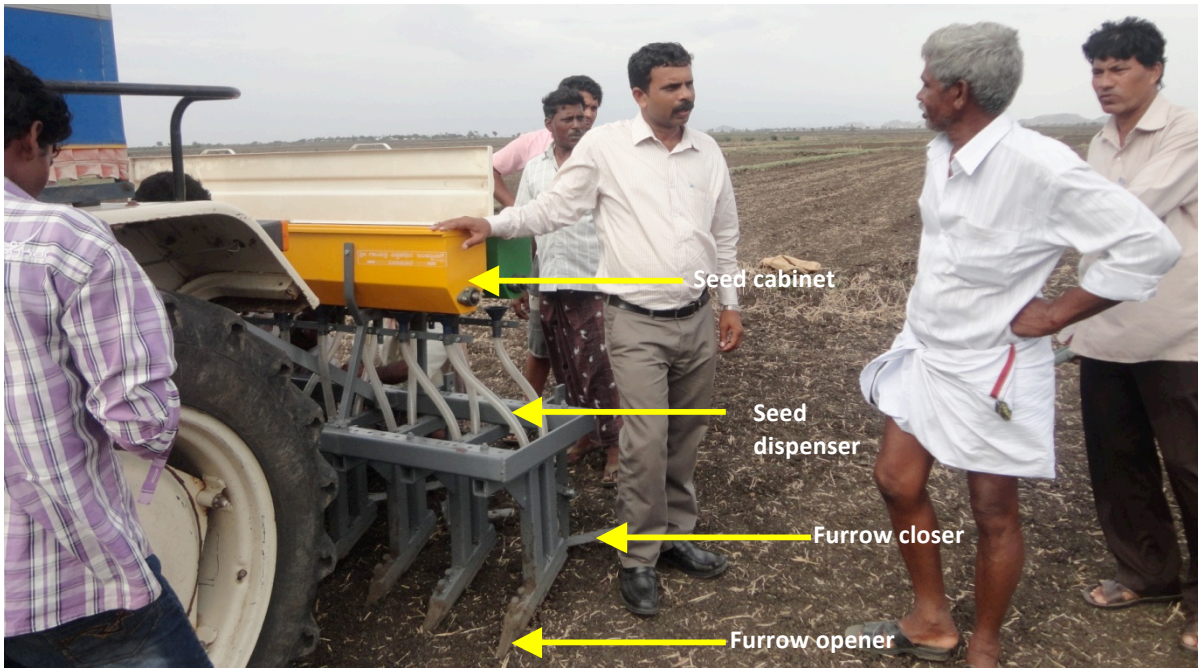
This usually happens due to uneven surfaces. This condition leads to loss of crop in the entire plot due to excess water at one side and moisture stress on the other side. *The plots must be properly levelled using tractors with wooden levellers. The mounds, shrubs, tree trunks and other unwanted structures should be removed to ensure uniform distribution of water across the length and breadth of the plot.*

High seed rate: Seed rate used by paddy growers is 50 to 60 kg/acre under broadcasting, which is very high and adds to the cost of cultivation. *Instead of broadcasting, direct sowing with seed drill or seed placement by dibbling is the best practice. If used correctly, 8 to 10 kg/acre seeds are enough to maintain the ideal plant population*. The seeds sown in dry soil will also remain viable and germinate once the rains are received or adequate moisture is reached.

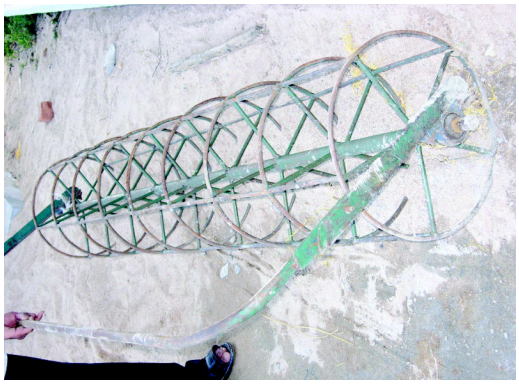
Land prepared and levelled for direct sowing

Direct sowing using tractor drawn seed drill

Eight rows can be sown at a time using this tractor operated seed cum fertilizer drill. It can also be used for fertilizer application simultaneously. The fertilizer is placed in green cabinet and seeds in yellow cabinet. In this method seeds are placed 4 to 5 cm below the top soil, enabling seeds to be sown in dry soil. The seeds will germinate once they receive rains, as long as seeds remain viable (up to 45 to 50 days).

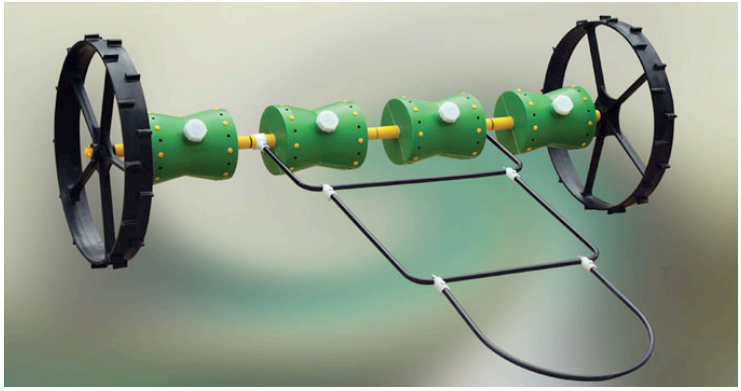


SRI method rice marker: it can be used for dibbling and transplanting



Close up view of SRI marker, easy to fabricate locally

SRI method of paddy planting under puddled conditions and direct planting under rainfed conditions



Direct sowing seed drum for paddy for irrigated and rainfed areas

Filling pre-germinated seeds in drums

Sowing on puddled field

Paddy grown by seed drum method

The SRI method uses on only 3-4 kg seeds per acre with a single seedling per hill.

Non availability of seed of improved varieties: Availability of certified quality seeds is a major problem. Many farmers use farm-saved seeds from their previous season and sometimes grain from the market is used as seed. A new paddy variety called SARRO-5 is high yielding but needs nitrogen application and good management practices. It is also susceptible to Rice Yellow Mottle Virus (RYMV). Apart from SARRO-5, no new varieties are available in the market. Farmers have their own traditional varieties which occupy much larger area than SARRO-5. They give poor yields but are preferred due to their aromatic nature.

The high price for seeds TShs.1500-2000/kg and very limited availability tempt many farmers to go back to their local varieties that are sold at TShs. 500/kg. There are no seed companies doing any seed production and marketing for paddy, except private companies/agencies that produce seed for their own farms and contract growers. Government agencies and research stations are also not involved in paddy seed production and marketing.

Two years ago the private seed company **Tanseed International Ltd**. started paddy seed production and marketing. Its current production is not even sufficient for 0.1% of the total paddy grown, but is gradually increasing. There is a need to build a sustainable paddy seed multiplication and supply system. The company can contract more certified seed growers and increase the area under seed production to meet the demand. *Farmers equally need to be educated about use of improved varieties and their yield benefits. More demonstrations could be organized and field days held on these demonstration plots to attract and educate more farmers about the new varieties.* The number of agro-dealers at village level is negligible and farmers often have to travel 20 to 40 km to agro-dealers based in district headquarters to buy seeds. There is a need for agro-dealers at village level, who can supply seeds, fertilizers and plant protection inputs for paddy. *More efforts are needed to attract rural entrepreneurs and farmers associations to deal with paddy crop inputs. The concept of mobile seed and agri-inputs counters during the paddy season will help farmers in remote areas and provide employment opportunities for rural youth.*

From the field observations and discussions with farmers, it is clear that varieties with aromatic character are preferred and are in high demand compared to non aromatic types. However, no seed company is doing seed production or research on these aromatic varieties which do not have a known pedigree. *Researchers should consider this fact while selecting varieties for release in this area and also use aromatic traits while breeding new varieties*.

Sometimes the poor quality seeds and self saved seeds adds to the higher seed rate used for sowing. Higher chaffy seeds are also a quality issue. Disease and pest incidence at grain maturity lead to more chaffy seeds, ultimately causing poor stand in the main field. To remove the chaffy seeds use brine (salt) solution (follow egg flotation method to prepare the solution). In brine solution after mixing the seeds chaffy will float and can be separated. The sunken seeds are washed and used for sowing. It is good to *treat seeds with Carbendazim 1 gm/kg before sowing to avoid seed borne diseases and possible incidence in nursery stage*.

Removal of chaffy seeds using brine solution

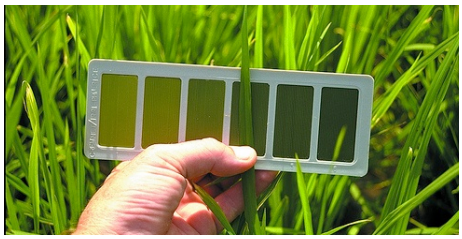
Non availability of mineral fertilizer at village level: Mineral fertilizers are not commonly available at village level. If farmers decide to buy they must travel to towns and district headquarters, which are not well connected. Many smallholders are not applying any fertilizers and also lack purchasing power. There is almost no use of organic manure. Credit facilities are lacking in rural areas. All these factors together make farmers reluctant to buy and use fertilizers for paddy.

Improvement of roads and transportation could help more farmers to buy and transport fertilizers. Good connectivity is the key to commercialisation of the rice value chain in Kilombero district. Wide scope exists for establishment of new agro-dealerships. Young and educated rural youth and those who are engaged in paddy/rice trade can be encouraged to take up this venture. They could market inputs and also buy the produce for trade.

Little use, poor knowledge and reluctance to use mineral fertilizers: Use of mineral fertilizer in paddy is essential especially nitrogen, phosphorus and potash. But its use in rainfed paddy is very poor (<5%). Many think their soils are virgin and do not need fertilizers, or fear that soils will be polluted by fertilizer. Only those farmers who had some formal trainings by developmental agencies are aware about fertilizers and their benefits and are using. Generally 1 bag (50kg) DAP or urea is used at the time of sowing or one or two months after sowing. Some progressive farmers who can afford to buy and practice partial mechanized paddy cultivation apply 1 bag (50kg) of DAP at the time of sowing/transplanting and one bag (50kg) of urea one or two months after sowing. Low fertiliser use substantially reduces the expected yield.

Farmers in Kilombero are not much aware about the benefits of fertilizer. *They need to be educated about appropriate fertiliser use by conducting demonstrations with village leaders. Farm schools, field visits and field days can be organised. More agro-dealers should be trained on guiding farmers to use fertilizers for better yield. The best time to apply nitrogen fertilizers is at transplanting and panicle initiation stages, any application after flowering leads to spikelet sterility and delays tiller production.*

Use of Leaf Colour Chart (LCC) can be introduced for effective nitrogen fertilizer management. Its application is essential but at optimum level. The LCC enables farmers to judge the nitrogen requirement by their paddy crop on their farm without any destructive/analytical method. The matching of colours in LCC will guide nitrogen application.



High weed infestations: Grass family weeds were common in all the fields in the entire rainfed paddy system. The infestation was so high that it became difficult to differentiate the crop from weeds in severely infested plots. Weeds on roadside and bund side are the main source to continue throughout the year. These weeds also act as alternate source for pests and diseases to survive during the off season. Although farmers are using herbicides (2,4-D, paraquat and glyphosate) but complete eradication remains a challenge for all the paddy growers. *For effective weed management Integrated Weed Management (IWM) practices should be followed. They include summer plowing; regular cleaning of bunds by manual weeding or herbicide sprays, clean crop cultivation, regular weeding till grain filling, removal of weeds before they flower, use of appropriate herbicides, regular inter-cultivation practices all together helps to check the weed population and also reduce insects and diseases.*

Most common grassy weed in paddy plots

Paddy plot with high weed infestation

Simple technologies can be introduced for better weed management: for example cycle weeder for rainfed and cono weeder for irrigated and rainfed conditions. These are cheap, easy to operate and reduce drudgery.

Conoweeder (manual operated)

Conoweeder in paddy plot

Power operated paddy weeder

Poor knowledge of rice pests and diseases among growers and agro-dealers: Paddy is prone to disease and pest attacks. Most paddy growers are not aware of the losses they cause. They notice leaf folders, hoppers; chaffy panicle (caused by stem borer) and sooty mold (caused by fungus) but do not take up any control measures. However, some trained paddy growers and those who do large scale paddy cultivation spray a mixture of choloropyriphos and a fungicide irrespective of pest and disease they notice. The main diseases noted in rainfed areas during the visit were bacterial blight, leaf blast, neck blast, sheath blight, brown spot false smut, and grain discolouration. Some farmers and traders mentioned the threat of RYMV but this was not seen during our visits.

Sooty mold and hoppers

Sheath blight

False smut

Grain discolouration

Chaffy panicle by neck blast

Leaf blast

Bacterial leaf blight

Stem rot

Stem borer infested panicle

Among the pests brown plant hopper, stem borer, green hoppers, leaf folder, cut worms, termites, thrips, mealy bug and some beetles were noted. Farmers are not aware that these will reduce yield. *When shown the symptoms from an identification hand book, farmers identified them correctly but were not aware they were diseases or pests. This is a clear indication that more farmer education is needed*.

Many agro-dealers do not have enough products of fungicides and insecticides. They stock a few high margin low priced products that are not so useful to paddy except cholopyriphos and hexaconazole. Bacterial blight is severe but no chemical is available in the market for management. Many dealers are also not aware about diseases and pests. They sell chemicals to spray, simply based on the farmer's explanation. *It is essential to educate the farmers, seed growers, agro-dealers and farmers' association members about different pests and disease of paddy and their management. Agro-dealers could be specifically trained on different insecticides, fungicides, bactericides and other plant protection chemicals used in rice. NAFAKA could produce a user friendly hand book with photos of pests and diseases and their management. This will be of great value to all paddy growers, seed producers, agro dealers and also extension workers. The project in collaboration with research institutes can recommend effective and eco-friendly chemicals for plant protection.*

Poor tillering and panicle formation: Tillering in rice is directly related to variety, spacing season and nitrogen application. In many plots poor tillering was recorded. In broad cast method tillering average ranged from 4 to 6 and maximum was 8/hill. It was less than 10 in all the plots visited. In case of dibbling it ranged from 16 to 18 and maximum was 20. In case of transplanting it ranged from 25to 26 and maximum was 28. Although some plants had up to 40 but most of them were non-productive formed after flowering. Based on the number of productive tillers panicles will form. *Usually a good variety have 100 to 129 spikelets per panicle but here the spikelets were below 40 it may due to drought, weeds, poor variety, low nitrogen application, improper spacing and poor management practices. For one square meter 300 to 340 productive panicles are expected for an ideal paddy crop. This can be achieved by use of high yielding variety, use of certified seed, proper*

spacing, weed management, application of recommended dosage of fertilizer, pest and disease management and following good agronomic practices.

Poor harvest and post harvest practices: Paddy harvesting in rainfed areas is commonly done very late even after the crop attains maturity. In spite of physiological maturity, farmers leave the crop in field for further drying believing that it helps in separating the grains while threshing. This is a very wrong practice by which paddy quality deteriorates. Paddy harvesting should be done when it reaches moisture level of 18 to 20% but no farmer is practicing this in the entire rice belt of Tanzania.

No proper equipment or implements are available for harvesting. Currently farmers harvest paddy by cutting the stem 5 to 6 inches above ground level and leaving it in the field for further drying. Some of them heap and do threshing later. This delay leads to shattering and loss of 10 to 25% grain yield. Threshing is done by beating the dry panicles with a stick or smashing on a wooden plank. In the former method paddy grains get broken even when gently beaten due to over drying and brittleness of grains. Some farmers dry the grain after threshing and winnowing. Drying during day time and heaping during evening leads to gain and loss of moisture which reduces the rice quality by increasing the percentage of broken grains upon milling.

Harvested paddy left for drying

Threshing using a tractor

Paddy left for drying in field

Heaped paddy for later threshing

Threshing by beating

For seed production drying should be done carefully after threshing; threshed seeds should be dried immediately in a systematic manner. Otherwise deterioration due to high respiration rate may occur. If the seeds are heaped without drying, temperature of the seeds may increase. Optimum time for drying the seeds under sun is 8 am to noon and 3 pm to 5 pm. Drying of seeds between noon and 3 pm should be avoided as temperature as well as intensity of ultra violet (UV) rays are high during this time.

Continuous drying of seeds from morning to evening under sun should be avoided. The seeds should be spread evenly every day after sun drying allowing free aeration otherwise, heating will occur resulting in lowering of seed quality

Currently farmers do not have any kind of mechanized equipment to harvest and thresh the paddy. *There is a need to introduce large / mini combine harvesters or multi-crop threshers which can save 15 to 20% losses faced by present harvesting and post harvest methods. Grain quality will improve, broken grain percent will come down, labour will be saved, admixture of inert material stones and chaffy grains can be removed. Over all timely harvesting is possible. Efforts are also needed in educating the farmers on proper drying to safe moisture level for harvesting, threshing, grain storage and seed storage. Farmers along with millers can be trained on safe handling of paddy to reduce the broken grain % in milled rice, which is key factor in deciding the rice price in market. Moisture meters may not be available but physiological indicators can be taught to farmers and traders*.

For proper harvesting and threshing mini combiners or threshers can be introduced in the project area. This is a long standing problem which should be considered for seed producers also, since high percentage of broken grain will reduce the germination percentage and quality of seed.

Mini combine harvester

Multi-crop thresher (tractor and diesel/electric engine operated)

Harvesting paddy using mini combine harvester

Poor transportation and storage facilities: Kilombero is well connected with Morogoro but not with other places including Ifakara and many villages. Poor roads and inadequate transport infrastructure are the major hurdles in development of rice value chain in Kilombero. There is for local and regional government authorities to address the issue. We learnt that USAID is considering funding roads and other basic infrastructure developments in Kilombero. This initiative will greatly assist farmers and the entire community.