Funded by the Ministry of Agriculture, Forestry and Fisheries of Japan

Feasibility Survey Project on Agricultural Mechanization for the Small Scale Farmers in Sub Sahara Africa
-Acceleration of Agri-Business -

Final Report –Second Year-

March 2015

JAICAFジェイカフ

Japan Association for International Collaboration of Agriculture and Forestry

Japan Association for International
Collaboration of Agriculture and Forestry

AKASAKA KSA BLDG. 3F
8-10-39, AKASAKA, MINATO-KU
Tel: +81-3-5772-7880
Fax: +81-3-5772-7680

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Preface

In East Africa, the rapid population growth is causing a quantitative expansion for the demand of food, and the production of rice and wheat cannot keep up with demand due to the change in people's taste. There are various factors to the problem, but their inability to free many farmers from agriculture depending on rainwater and human power is an obstacle. The mechanization of agriculture is noted as one of ways to overcome this difficulty.

Based on the circumstances, we, JAICAF, with subsidies from the Ministry of Agriculture, Forestry and Fisheries of Japan, have been implementing Feasibility Survey Project on Agricultural Mechanization for the Small Scale Farmers in Sub Sahara Africa since 2013.to implement an agricultural mechanization feasibility test for small scale farmers and survey of the current state of mechanization.

In the second year of this project, we continued the test by introducing a power tiller to an upland rice farmer in Uganda. And we started the test of introducing a power tiller and a combine harvester to irrigated rice field in Tanzania. As for mechanization overview survey, we also implemented survey in Ethiopia additionally. Furthermore, we conducted agricultural machineries demonstration in Uganda for transmission of information and promoting demand of Japanese branded machineries.

In this report, we put together the outline and the results of activities in mainly Tanzania and Uganda. We expect that our project results will contribute to the mechanization of the region and also be utilized by private companies as well as international cooperation related parties. We will be pleased if our report is of help to those concerned.

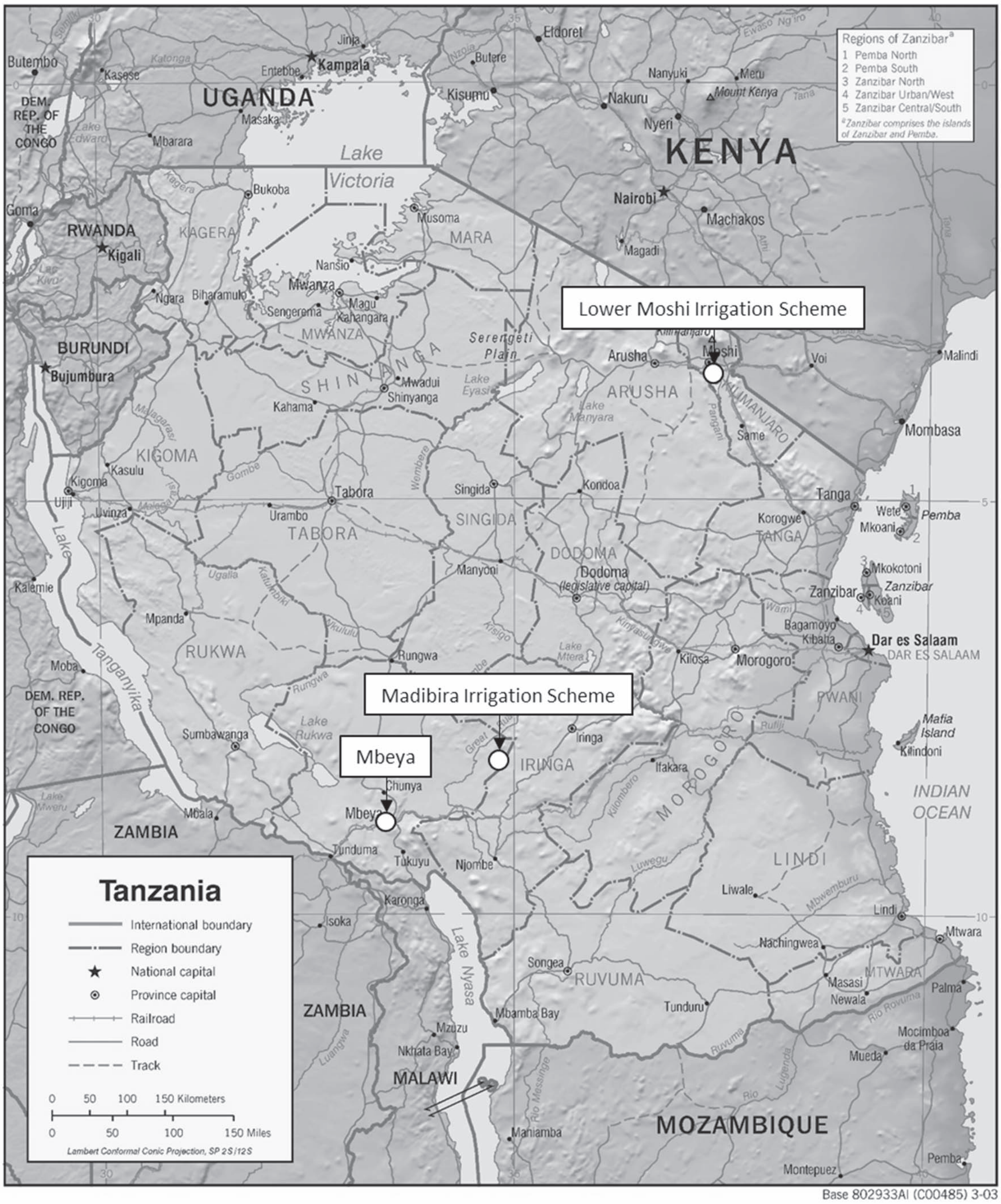
To implement and operate this project, we received a large amount of support from each specialist dispatched to the site. Also, the expert committee which was separately established in JAICAF headquarters gave us guidance and advice on planning of this project and the evaluation study.

Furthermore, for the activities by our specialists in the countries in concern, we received cooperation from a lot of organization: In Tanzania, the Japan International Cooperation Agency (JICA) Tanzania Office, the Project for Supporting Rice Industry Development (TANRICE-2) and Kilimanjaro Agricultural Training Centre (KATC), In Uganda, JICA Uganda Office, Promotion of Rice Development (PRiDe) Project and Agricultural Engineering and Appropriate Technology Research Centre (AEATREC), In Ethiopia, JICA Ethiopia Office, Farmer Research Group Project (FRG) II and Mennonite Economic Development Associates (MEDA). We deeply appreciate their cooperation.

Lastly, we wish to make clear that this report was made based on our association and does not represent the opinion of the Ministry of Agriculture, Forestry and Fisheries and the Japanese Government.

March, 2015

Ryuzo Nishimaki, President
Japan Association for
International
Collaboration of Agriculture
and Forestry



Project Map (Tanzania)

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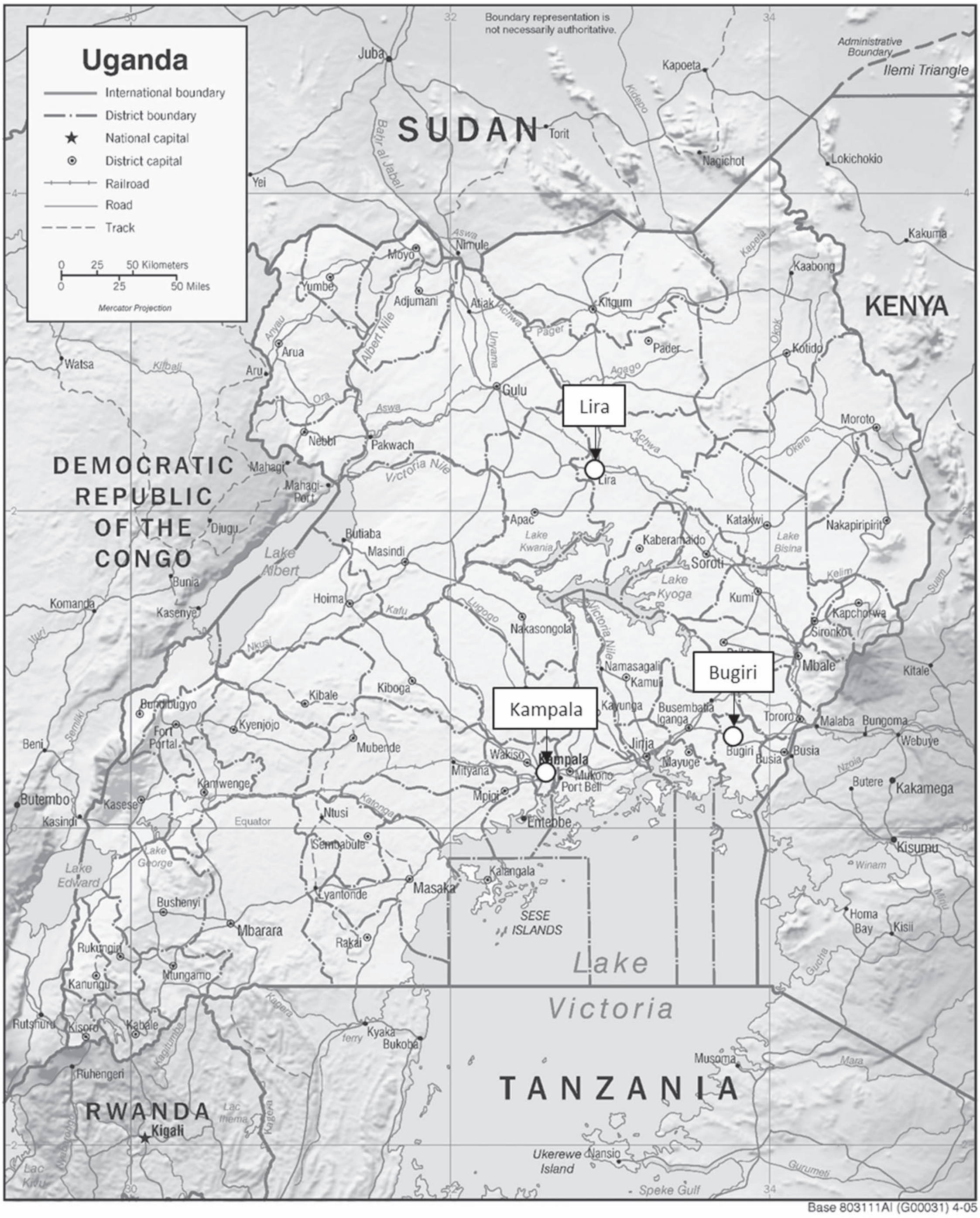

Project Map (Uganda)

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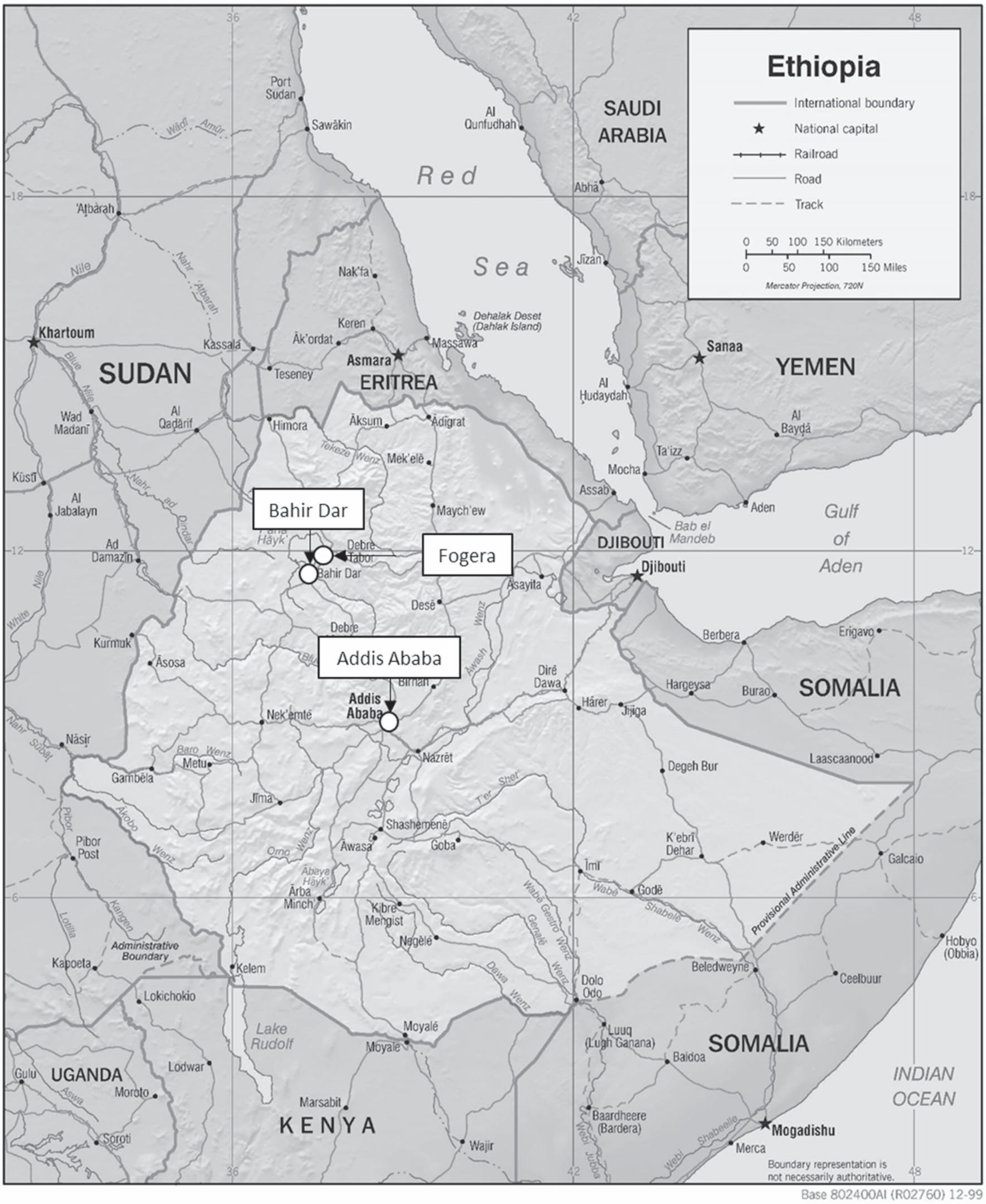

Project Map (Ethiopia)

CIA Maps, Ethiopia (https://www.cia.gov/library/publications/cia-maps-publications/Ethiopia.html : access date March 9th 2015)

Project Photos (Tanzania)

Photo1 Lower Moshi Irrigation Scheme in Kilimanjaro, Tanzania

Photo4 Ploughing with power tiller (Rotavator plot)

Photo2 Experiment plot of Kilimanjaro Agricultural Training Center: KATC (After flooding)

Photo5 Puddling with power tiller (Rotavator plot)

Photo3 Land levelling using hoe (Man power plot)

Photo6 Rake was used for power tiller plot

Photo7　Harvesting mannually

Photo8 Threshing mannually

Photo9　Harvest and threshing experiment by combine harvester

Photo10　Madibira irrigation scheme., Mbarali district, Mbeya region. About 3000ha.

Photo11　Rice miller clusterat in Mbeya. Japanese rice mill machine manufacturer joined the survey.

Photo12　Japanese branded power tillers popular around Mbarali ditrict, Mbeya region.

Project Photos (Uganda)

Photo13 Cultivation land of Lira

Photo16 Attach seeder to the power tiller for sowing. The farmer's income increased by providing ploughing and sowing services to nearby farmers.

Photo14 Trial by a rice farmer in Lira District. Power tiller made ploughing easier even in the field overgrownd by weed.

Photo17 3WM, the company rented the Japanese branded power tiller to this project, provided maintenance service.

Photo15 Second ploughing by disc plough

Photo18 Harvesting using reaper. Upland rice plot harvested 1-2t/ha.

Photo19 Joined an event in Lira District on World Food Day. (from left: weeder as imprement, rotary weeder、seeder, power tiller, Japanese plough)

Photo20 Announcement of the power tiller demonstration. Agricultural department managers from three districts answered questions from the farmers.

Photo21 Demonstration at Otuke District. Introduced the usefullness of power tiller to the farmers.

Photo22 Demonstration at Alebtong District with farmers' participation

Photo23 Demonstration at Lira District. Introduced maize sheller.

Photo24 Demonstration of de-stoner. Japanese de-stoner manufacturer participated to this demonstration

Project Photos (Ethiopia)

Photo25 Fogera, Amhara Region, near lake Tana

Photo26 Rice field in lowland. Water comes up to waist during rainy season (Fogera)

Photo27 Farmers attache plough to two oxens to plough (Fogera)

Photo28 Threshing done by oxens on rice straw

Photo29 Agricultural products are carried by donkeys. Mechanization is necessary not only for production but all the aspects of agricultural marketing.

Photo30 Agricultural machinery exhibition place near Adama, Oromia Region. Entrepreneurs and farmers come to buy (from left: power tiller, trailer, tractor)

Abbreviations List

Abbreviation	Standard name
ACSI	Amhara Credit& Saving Institution
AEATREC	Agricultural Engineering and Appropriate Technology Research Centre
ASDP	Agricultural Sector Development programme
ATA	Agricultural Transformation Agency
CAMARTEC	Center for Agricultural Mechanization and Rural Technology
CARD	Coalition for African Rice Development
JAICAF	Japan Association for International Collaboration of Agriculture and Forestry
JICA	Japan International Cooperation Agency
KADP	Kilimanjaro Agricultural Development Project
KATC	Kilimanjaro Agricultural Training Centre
MEDA	Mennonite Economic Development Associates
NaCRRI	National Crops Resources Research Institute
NMB	National Microfinance Bank
NRDS	National Rice Development Strategy
NSGRP	National Strategy for Growth and Reduction of Poverty
ODA	Official Development Assistance
ORDA	Organization for Rehabilitation and Development in Amhara
PRSP	Poverty Reduction Strategy Paper
SAA	Sasakawa Africa Association
SACCOS	Saving and Credit Cooperative Society
SAGCOT	Southern Agriculture Growth Corridor of Tanzania
SIDO	Small Industry Development Organization
TAFSIP	Tanzania Food Security Investment Plan
TIB	Tanzania Investment Bank
TICAD V	Tokyo International Conference on African Development
TDV	Tanzania Development Vision
UNBS	Uganda National Bureau of Standards

Tanzania Shillings :
1 USD = 1,386.92 Tsh (http://ja.exchange-rates.org/Rate/USD/TZS, March 4th 2015)
Uganda Shillings :
1 USD = 2,933.18 Ush (http://ja.exchange-rates.org/Rate/USD/UGX, March 4th 2015)
Birr（Ethiopia）:
1 USD = 20.3598 Birr (http://ja.exchange-rates.org/Rate/USD/ETB, March 4th 2015)

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in Sub Sahara Africa -Acceleration of Agri-Business - Final Report –Second Year-

―Table of Contents―

Chapter 1 Project Report Summary

1. Objectives of Project

In Sub-Saharan Africa (SSA), malnutrition amongst the population is as high as 30%; poverty and starvation issues are worsening in recent years due to soaring international food prices. Ensuring food security of the region and alleviation of poverty are crucial to resolving these issues, and measures include the increase in agricultural production through direct investment in agriculture that is the key industry of the area and improvement in productivity. In these circumstances, the objectives of this project are the promotion of investment by the private sector in the agribusiness in SSA through demonstrations of increased agricultural production and improved productivity through the introduction of agricultural machinery, as well as increasing farm incomes and reducing regional poverty.

2. Overview of Project

1) Feasibility study of mechanization

For the purpose of developing agribusinesses contributing to poverty reduction, and increasing farm income through production, processing, and sales, a model test has been carried out in rural areas, where there is the possibility of popularizing agricultural machinery, through introduction of agricultural machinery (mainly driven by motive power) on a trial basis building.

2) Development and promotion of agribusiness

Feasibility surveys have been conducted around the particular needs for development and promotion of agribusiness with the private sector in the countries where the feasibility study were conducted. In order to achieve the expansion of business in future, field surveys were also done in Ethiopia. For the development of a sustainable agribusiness, based on the results of feasibility surveys and analyses, experts were dispatched to the regions to hold workshops and demonstrations targeting farmers, engineers, and extension workers to guide them in the use of agricultural machinery and equipment.

3. Summary of Results

1) Following the upland rice trials in Uganda last year, irrigated rice field trials were conducted this year in Lower Moshi area, Tanzania. The cost difference between labor and machinery of preparation of land and harvesting tasks per unit area was small. However, labor took 14 times longer for ploughing, puddling and leveling, and 32 times longer for harvesting than mechanized activities.

2) Therefore, a significant advantage can be identified for labor productivity with machinery if the cost is the same. Despite farming still relying on labor in East Africa, the outflow of young people to the city and their unwillingness to work tends to grow so that the delay in farming is found everywhere, due to the insufficiency of labor at the right time. Especially since the suitable period

for rice cultivation is limited, so the yield will drop dramatically if the optimum time is missed. These are the major causes of rice production not meeting the increasing demand in East Africa; the improvement of labor productivity through mechanization is an urgent issue. (Although not getting direct data about the improvement of land productivity through mechanization and the increase of yield per unit area, the studies in the Lower Moshi plots resulted that puddling by mechanical tiller reduces the water requirement rate in the paddy field and exhibits less weed growth compared with puddling by hand. In addition, it is suggested that harvesting at the most opportune time is possible if the harvesting can be performed quickly. In determining from these results, the mechanization improved the productivity of the land).

3) There are several reasons for inhibiting the introduction of mechanization on small-scale farms in East Africa:

- Use of animal power was limited;
- No funds to purchase machineries;
- Rural finance institutions available for purchase have not developed;
- Could not earn income worth the cost;
- No repair system; Lack of experience as an operator;
- Machinery spare parts not available;
- Inexpensive second-hand machines are not available unlike used-cars;
- Japanese branded machineries are more expensive than those made in China and India. According to the reasons above, it is expected that the adoption of mechanization amongst rice farmers still need quite some time.

4) In these circumstances, rice farmers who have fund-raising capabilities have been emerging in the Bugiri and Lira District of Uganda and the Mbeya Region of Tanzania. They raised the funds to purchase Japanese branded power tiller and then farmers not only plough their own field by power tiller, but also plough other farmers fields by contract to increase the effective use of the machinery in order to recover the funds they invested. If the reasons limiting mechanization stated above are resolved one by one, mechanized farming in East Africa has great potential for farmers and for Japan's agricultural machinery manufacturers. The benefits of mechanization should be suitable to tillage and harvest at the right time; on the other hand, it would be a serious blow for the owner if the machine has a failure and does not work at the proper time. Therefore, in Mbeya Region of Tanzania and some other areas, farmers who have ownership experience of power tillers tend to replace their power tillers with more robust Japanese branded power tiller even though they are more expensive.

5) Another key factor of rice production in SSA contributing to the production falling short of consumption is the lack of appropriate post-harvest equipment and technology. Especially, from the consumer perspective, they prefer imported rice because the rice harvested in SSA contains

impurities such as small stone. The feasibility surveys were conducted, with the participation of the Japanese private sector such as Satake Corporation and Hosokawa Works Co., Ltd., to investigate the possible entrance of Japanese companies in the field of rice milling and de-stoning. The participating companies each seemed to have identified the potential of the rice market in SSA.

6) In Fogara around Lake Tana in the Amhara Region of Ethiopia, the rice crop has been gradually spread out mainly planting sativa, X-Jigna (regarded it has same gene as Japanese rice. Nippon-bare), which was brought with the help of North Korea fifty years ago. Currently, Fogara has become one of the major rice production area and is expected to further develop in the future. Animal power is used actively, unlike Uganda and Tanzania, and the introduction of the power tiller has yet to happen. However, the JICA rice project is scheduled to start soon, and it is expected that there will be great changes through machinery based on the farming use of animal power.

7) In the Lira region of Uganda, demonstrations of Japanese branded machineries were held in this fiscal year. Very high demand for power tillers as well as harvesting and threshing machines was revealed on this occasion. Manual harvesting and threshing are commonly recognized as women's work and the mechanization frees women from the heavy work. It is quite natural that women's interest in mechanization is high, but men also showed a great interest. There were many requests for the machinery to be on lease or hiring service because it is difficult for them to buy it.

8) It is expected that there may be concerns about fewer employment opportunities if agricultural machinery were to be introduced. As stated above, young people in rural areas are relocating to the city and even those remaining are unwilling to undertake manual labor. If mechanization progresses, it is expected that the increasing of yield, the activation of the economy of the entire region, and new employment opportunities for operators, repairers, small businesses including parts sales, and rice milling. Power tillers can be also used for transportation connecting with a trailer in order to carry water from the water site to the village. This will free women and children from the drudgery of carrying water. The rice farmers in Uganda and in Tanzania are also field farmers or livestock farmers in general rather than specialized as rice farmer. In Bugiri in Uganda, farmers used power tillers in maize shelling work using its power and earning income. The farmers said that they could recover the funds for the purchase of the power tiller within five years with just this work.

9) The power tiller of rotovator-type is very common in Japan. However, fields in SSA are typically not maintained well or very solid so it is make sense that ploughing with the power tiller of traction-type towing the plough or harrow rather than using a rotovator-type. In fact, power tillers of traction-type have been produced by Japanese manufacturers in Thailand and Indonesia and are often used. Headquarters of the Japanese manufacturers should also take into account the implementation of equipment that has specifications adaptable to local farming in SSA.

Chapter 2 Results of Feasibility Survey Project of the Development and Promotion Model for Agribusiness

1. United Republic of Tanzania

1) Present situation of farming and agricultural mechanization in the United Republic of Tanzania

(1) Current status of rice farming

Rice consumption continues to grow with the increase of the population, it was 65,000 tons in 1960 and increased to 916,000 tons in 2011 (USDA databases). Especially in the urban areas, the trend in diet is away from the traditional staples, such as maize and potatoes, to a rice diet with the increase in income. Rice production has risen to become second to maize and is considered as the most important food crop from the food security perspective. The Tanzanian government announced the National Rice Development Strategy (NRDS) in 2009 that aimed to double rice production by 2018, from 875,000 tons in 2008, which shows the importance of rice.

Rice cultivation is broadly classified into three categories: irrigated rice, rainfed lowland rice, and rainfed upland rice as implemented in the agricultural ecosystems. According to the NRDS, the irrigated ecology covers 200,000 hectares[1], (29%) while rainfed lowland rice area covers 464,000 hectares (68%), and rainfed upland rice area covers 17,000 hectares (3%). (The numbers are referred to the data in 2008 and the percentage in parenthesis indicates the proportion of each agricultural ecosystem to the total area.) The Tanzanian government has been promoting rice production and productivity improvements by spreading modern rice cultivation technology, such as the introduction of improved varieties, straight row transplanting and chemical fertilizer application, throughout the increased irrigated area.

It is said that 2,762 irrigated areas have been developed throughout the country and rice farming is carried out in 938 areas (interview with Directorate of Irrigation and Technical Services, Ministry of Agriculture, Food Security and Cooperatives). Modern rice cultivation technology has been well established in the Lower Moshi irrigation scheme with the continued cooperation of the Japanese government since the 1970s and the average yield in paddy has achieved 6-7 tons/ha. Other irrigated areas have established modern rice cultivation technology by receiving rice cultivation training from the agricultural training institute, which is affiliated to the Ministry of Agriculture, Food Security, and Cooperatives, and the yield has been improved.

The rice cultivation of rainfed lowland has mainly expanded to the Shinyanga and Mwanza Regions and the water harvesting-based rice production is used. These two regions account for 33% of the total area of rice production and 31% of the total amount of rice production (National sample census of agriculture 2007/2008). The rice cultivation technology for rainfed lowland is applied the extensively, and generally grows the traditional late maturing varieties typified by Supa, seeding

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[1] The irrigated area was increased to 465,000 hectares by 2014.

application is mainly broadcast sowing, and fertilizer is almost unused. As a result, rice productivity is very low, the average yield of the Shinyanga and Mwanza regions is 1.5 tons/ha.

Local traditional rice varieties and upland rice grown in rainfed lowland are also cultivated in rainfed upland area. The cultivation method of rainfed upland is extensive and the productivity is very low in the same way as the rainfed lowland area.

Generally, rice seed is sown between November and December, at the beginning of the rainy season, and is harvested between May and June, at the end of the rainy season. Double cropping of rice has been introduced to some of the irrigation sites and dry-season cropping, where rice seed is sown between June and July and harvested between October and November, is being implemented.

(2) Current situation of agricultural mechanization

<1> Current situation of agricultural mechanization

There are 440,000 square kilometers of arable land in Tanzania, but only 100,000 square kilometers or 23% of total area is being used. Most of the agricultural work relies upon human resources and machinery utilization for ploughing, which is more likely to use a machinery than other work, and remains at 28% (see Table II.1.1). It seems that most of the farmers own small-scale farms between 0.2 and 2.0 hectares. The animal power utilization in the Shinyanga and Manyara Regions is high, 50% of arable land has been ploughed by animal power. However, it is difficult to introduce the labor force of animals into the region that did not use animal power. A delay in mechanization has become the one of the causes inhibiting the expansion of arable land area.

Table II.1.1 Farming power sources for small-scale farmers (%)

Power Source /Activity	Tillage	Planting	Weeding	Harvesting	Shelling	Transport
Human	29.0	84.5	93.7	98.2	94.5	35.4
Animal	43.0	9.3	5.4	1.5	2.9	37.0
Tractor/ Mechanical	28.0	6.2	0.9	0.3	2.5	27.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

* The survey was conducted with 359 farmers in 59 districts of 16 regions.

Source: Tanzania Agricultural Mechanization Strategy (MAFC) 2006, author created from the data

Figure II.1.1 shows rice cultivation area and paddy production. The rice production for the last 50 years, from 1960 to the present, was found to have grown only twice as much (see Figure II.1.2). This indicates that the production has increased by the expansion of fields.

In these situations, the labor force growth rate in agriculture is at 2.8%, which is lower than the 3.1% of overall industrial growth rate due to the migration from rural areas to urban cities, increase of non-farm employment opportunities, malaria and the HIV/AIDS epidemic. The mechanization of agriculture is important to make up for workforce shortages in the rural areas.

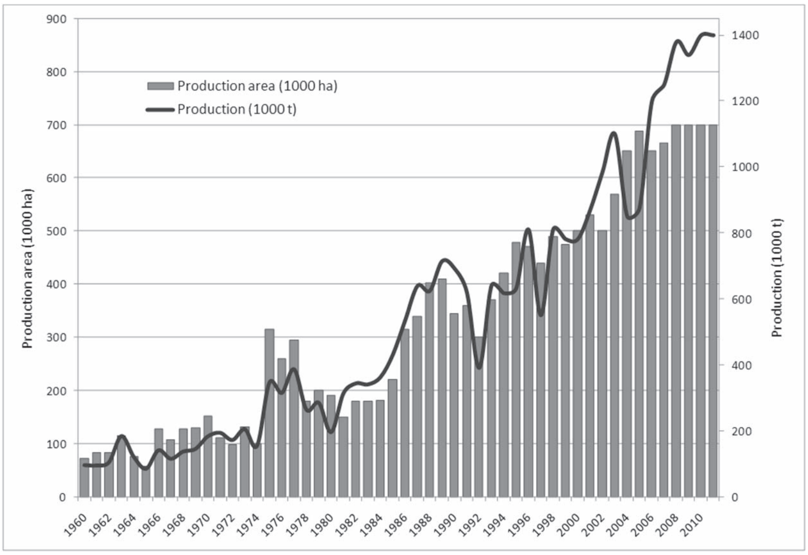


Figure II.1.1 Trends in rice production area and paddy production in Tanzania
Source: USDA author created from the database

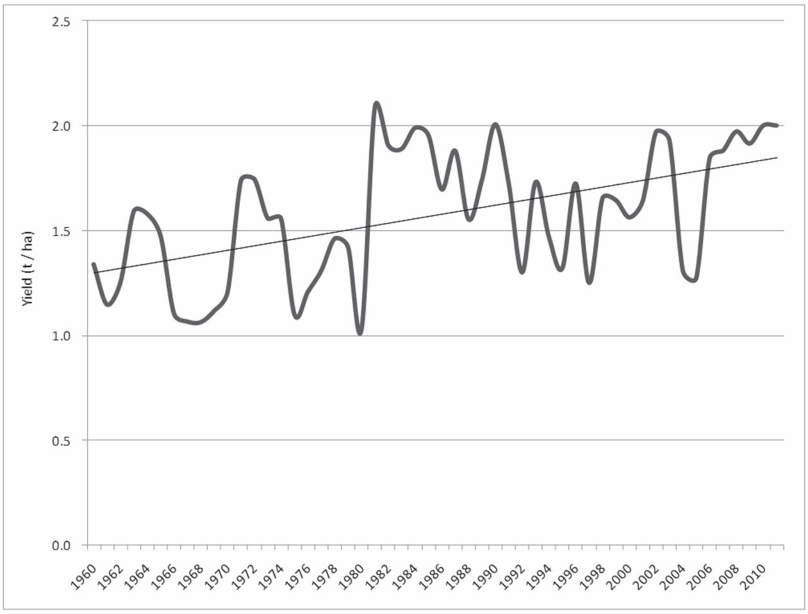


Figure II.1.2 Trends in rice production in Tanzania

Source: USDA author created from the database

<2> Mechanization progress to the present day

The number of tractors that were purchased is shown in Figure II.1.3. 70% or more of the tractors were introduced by purchasing or aid until the 1980s when it was under the planned economy. The Japanese government has provided 386 tractors to the Kilimanjaro Region as grant aid or food production aid. Many of the tractors are aged 20 years or more since their introduction and frequently break down. Although there are about 7,200 tractors running throughout the country, another 6,000 are unused despite being reparable because there is a difficulty in the supply of spare parts. It may be said that the tractors have broken down, but most of them will be fixed by replacing consumables. It is considered that the training of mechanics who can diagnose the faults properly is also important as well as the spare parts supply.

Figure II.1.4 show the trends in sales of tractors. After 1,143 tractors were sold in 1985, it has been on a downward trend, and currently the sales volume is 200-300 tractors/year. This is caused by the price increase of the tractors, in addition, purchasing power of farmer is reducing[2] due to the grain prices remained stagnant and low productivity, and there is no soft loans system available to small farmers.

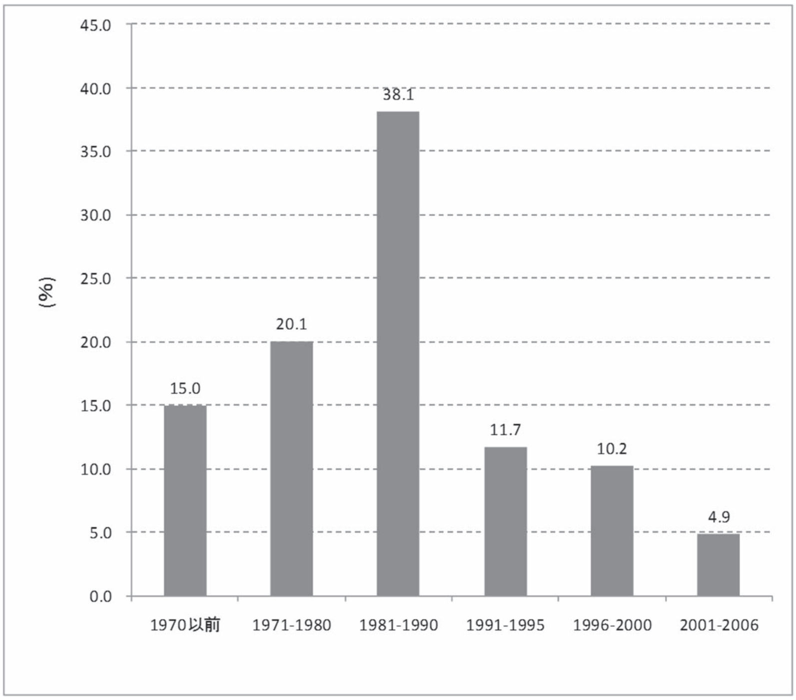


Figure II.1.3 Number of tractor units purchased

Source: Tanzania Agricultural Mechanization Strategy (MAFC) 2006, author created from the data

[2] The price of a 70-horsepower tractor and accessories including plough used to be comparable with the selling price of 87 tons of maize, now the price of the same sort of tractor is almost the same as the selling price of 300 tons of maize (Tanzania Agricultural Mechanization Strategy, 2006).

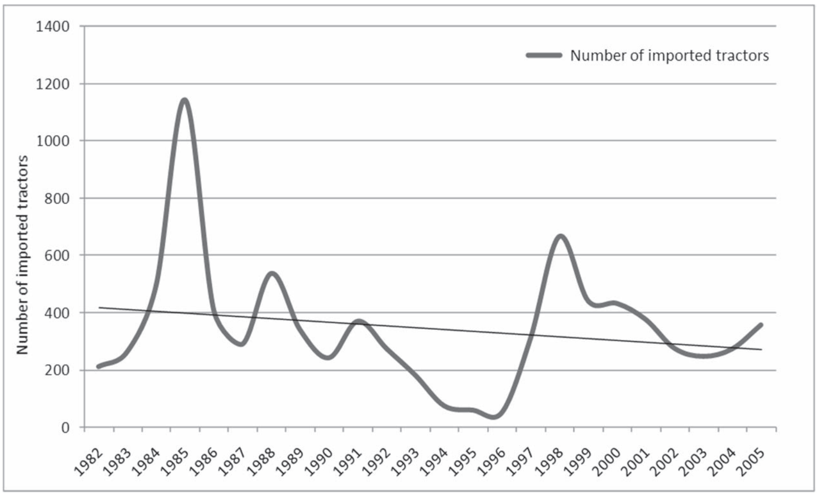


Figure II.1.4 shows the trends in sales of tractors.

Source: Tanzania Agricultural Mechanization Strategy (MAFC) 2006, author created from the data

<3> Situation of rice production mechanization

① Ploughing and puddling

Ploughing and puddling are performed by tractors, power tillers, animal power, and labor with hoes. In the Lower Moshi Irrigation Scheme, where the development completed in 1987, tractors are commonly used. The initial number of tractors was adequate, but the number decreased in recent years and has had a significant impact on farming as ploughing and puddling cannot be performed in a timely manner so that rice planting is delayed. Many farms apply the alternative method of puddling without ploughing. Rotovators are commonly used for puddling.

Photo II.1.1 Puddling by tractor

(Lower Moshi Irrigation Scheme)

Photo II.1.2 Puddling by animal power

Some farmers are using a tractor for puddling after seeding in rainfed lowland. When a tractor is used for ploughing, a disk plough is used. Ploughing can be performed twice with a disk plough, but harrowing to break up the puddled soils is often inadequate and it can cause fewer seedling establishment after broadcast sowing. In some cases, seeding amounts reach 100 kg/ha because of poor seedling establishment. With these situations, there is a possibility to improve the plot maintenance by conducting training in tractor operation, or implementing of disc or rotary harrow.

Photo II.1.3 Insufficient breakup of soil in rain-fed rice field

② Transplanting

Transplanting rice seedlings in straight rows has been popularized mainly in the irrigation area in the Kilimanjaro Region, an advanced rice cultivation area. However, broadcast sowing or random transplanting can be seen in many rainfed lowlands. With the aid of South Korea and other countries, rice transplanters were introduced to some irrigation areas on a trial basis. In addition, rice transplanters manufactured by Japanese affiliated companies are also being sold. Ministry of Agriculture Training Institute – Igurusi (MATI - Igurusi), which is one of the TANRICE 2 project implementation agencies, is providing training on how to use rice transplanters under the leadership of the Tanzanian government. In order to use a rice transplanter efficiently, thorough field maintenance, such as land leveling, is necessary.

Photo II.2.4 Transplanting rice (primarily by females)

Photo II.2.5 Rice transplanters being sold in Tanzania

③ Fertilization and agrochemical application

Fertilization is performed by a manual process. Herbicides and insecticides are commonly used in an advanced irrigation area such as Lower Moshi, and agrochemical sprayers are often used for crop dusting. Protective masks are used very rarely; pesticide bottles are often discarded in waterways. It is very important to disseminate secure spraying methods along with the spread of pesticides and equipment.

④ Weed control

The use of herbicide is gradually increasing, but mostly, it is still an arduous, manual task. TANRICE2 project is promoting a push weeder (simpler weeder than a rotary weeder).

Photo II.1.6 Weeding by push weeder

⑤ Harvest

Harvesting methods differ by the region, there is harvesting rice ears by sequentially reaping ripe spikelets or cutting the rice crop above the ground level. Instead of "Hasa-gake," which is drying rice on a rack and was very common in Japan in the old days, reaped rice is piled up and threshed immediately. Depending on the harvest time, harvesting must be done in the paddy field so that the rice crop is easily mixed with dirt or stones. The common method of hand threshing is beating the rice crop on a stone or on the ground. Easily threshed varieties are preferred by farmers. The post-harvest loss of grain in Tanzania has been reported to reach 30% to 40%; improvements are needed in rice cultivation. The combine harvester is being adopted in some of the irrigation areas. In particular, the combine harvester has been used in the Lower Moshi Irrigation Scheme since 2012, currently about 70% of the rice planting area is being harvested by combine harvesters, and it is rapidly becoming widespread.

Photo II.1.7 Harvesting with combine harvester (Lower Moshi Irrigation Scheme)

Photo II.1.8 General threshing work

Photo II.1. 9 Threshing work with platform

⑥ Drying

The rice crop is often dried on a concrete drying area or on tarpaulins (plastic sheet) which are spread on the roadside, mixing with stone that also happens to be there. Rice-milling plants that have moisture meters are almost nonexistent so that the appropriate drying has not been done. As a result, yields of whole grains are very low due to the excessive drying, and the percentage of broken rice reaches 40% to 50% in some cases.

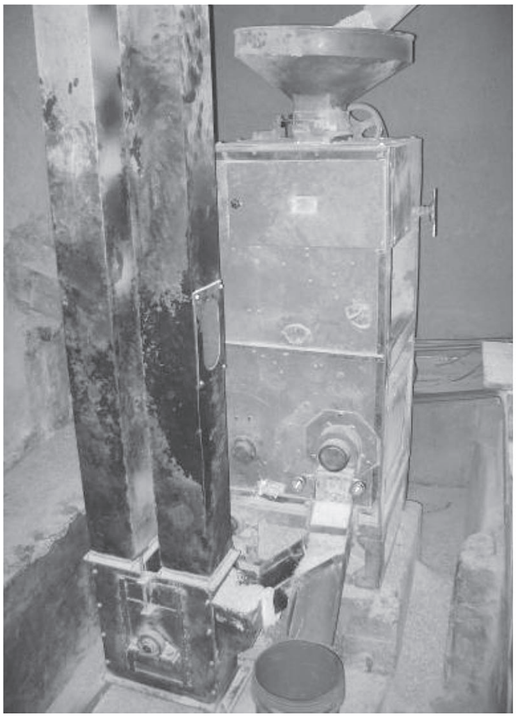


Photo II.1. 10 Made-in-China rice-milling machine (this type of machine can be seen often)

⑦ Milling

The one-pass type of rice-milling machine is becoming more and more common for rice milling. There are a number of rice-milling machines made in China that are most likely a copy of the Satake rice-milling machine. The performance of the copy machine is such that the product quite often contains impurities such as stone, the percentage of broken rice is high, so the quality of milling is lower. There is rarely a rice-milling plant that is equipped with a de-stoner or grain cleaner. Companies that implement plastic packaging are also gradually growing in order to increase the value added.

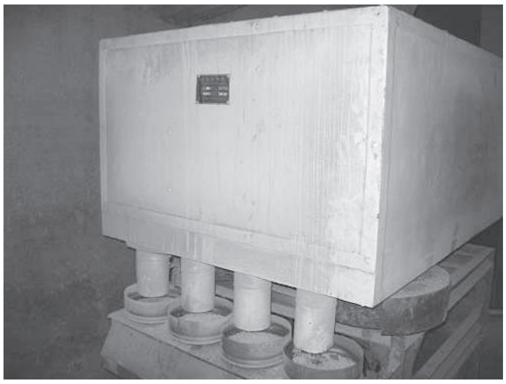


Photo II.1. 11 Made-in-China stone separator

<4> Institutions associating with agricultural mechanization

① Centre for Agricultural Mechanization and Rural Technology (CAMARTEC)

The major businesses of this Center are the development of prototypes of agricultural machinery (labor, animal power, and motorized) and farm equipment, performance tests and authentication of agricultural machinery. In 2008, the Center relocated to the current location and purchased high-performance steel sheet processing equipment for 1 billion shillings (approximately 50 million yen), which was funded by the government. Under the guidance of the British engineers who were funded by

Photo II.1.12 CAMARTEC tractor

CAMARTEC, the institution is working on the production of tractors utilizing the processing equipment. While many organizations cannot carry out their business without relying on external financing, they are promoting business using their own funds. However, it has not been proven that the agricultural machinery from CAMARTEC is used by many farmers, and it is considered that the tractor currently in production would be difficult to promote in terms of cost and performance. Since these facilities have no problem in the production of agricultural machinery, the key factor is reflecting the needs of consumers in production. In terms of the performance tests for imported agricultural machines, the volume of imports is increasing due to the liberalization of trade, and the implementation of tests cannot catch up because of the lack of human resources and budget.

② Small Industries Development Organization (SIDO)

In the SIDO industrial park, a private company is manufacturing maize threshing and other machinery. The technology is sufficient to produce a maize threshing machine. Similar agricultural machinery to that manufactured by SIDO is used in other African countries, and it indicates that this type of machine can certainly be manufactured in Africa. It is hard to say whether they are popular. For this reason, how to sell the machines rather than the capabilities of production should probably be considered. There are many factors including equipment price and sales promotion approach that should be considered in order to promote the machines, but neither SIDO nor CAMRTEC seem to consider them. In general, agricultural machinery is build-to-order, and this small-scale production increases the price per equipment. In addition, small companies do not have the capacity to develop a prototype based on the needs of the farmers, which means it is difficult to develop demand. This vicious cycle need to be broken in order to promote agricultural machinery.

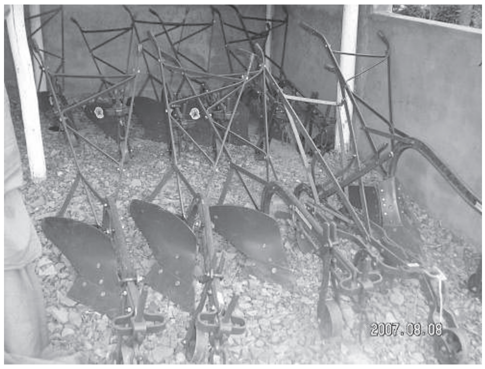


Photo II.1. 13 General farming equipment (ox plough)

<5> New movement and the potential of mechanization

The Tanzanian government purchased 230 power tillers in 2000 to 2002, and facilitates dissemination as an alternative to the tractor by demonstrations in rural areas. According to agricultural machinery sales by private-sector companies, approximately 100 units per year were sold and it is likely that the demand is increasing. As part of an agricultural modernization based on the Kilimo Kwanza (Agriculture First) agricultural policy, a project to distribute 50 power tillers to each district has been conducted. The power tiller is a highly versatile machine that can also be used to transport the crops and has been spreading out amongst farmers.

Made-in-China's cheap tillers dominate the market, but the reputation among the farmers is rather unsatisfactory due to unreliability. In contrast, Japanese branded power tillers' popularity is high and even used tillers are trading at high prices. However, there are beliefs that Japanese branded power tillers spare parts are difficult to obtain; it illustrates the issue of spare parts supply.

In recent years, Kubota launched the sales of power tillers through local subsidiaries and the spare parts supply system is also being developed. In addition, deployment of power tillers branded by other Japanese companies is also being considered. A stable supply of high-quality Japanese branded products is expected. Table II.1.2 shows the result of the interviews. The failure to sell the Japanese branded power tiller seems to be due to the difficulty in spare parts supply and the high price, but its durability and performance have already been recognized by farmers in Tanzania. The potential for sales has already been estimated at approximately 10,000 units (Japan External Trade Organization (JETRO) 2010).

Table II.1.2 Characteristics of Made-in-Japan and Made-in-China tillers

	Japanese branded PT	Chinese-made PT
Price	Expensive 900 mil. shillings about 6716 USD (Japanese Kubota) 3800 USD (Thai Kubota)	Cheap 250-300 mil. shillings about 1866-2239USD
Fuel consumption	Good 5 litters/acre	Bad 10 litters/acre
Spare parts	Difficult to obtain	Easy to obtain
Weight	Light (suitable for work in water)	Heavy (150kg)
Changing tires	Easy to change	Require time to remove 4 bolt
Durability	Not frequent failure	Frequent failure
Reason of purchase or not	Expensive Difficult to obtain spare parts	Cheap Easy to obtain spare parts

* Personal opinion of tiller owners
Source: The Japan External Trade Organization (JETRO) (2010) "New African market development promising business survey report /Agriculture, fishery, materials sectors in Tanzania"

Rice-milling machine is also estimated at 6,000 potential sales. The owner of Made-in-China rice-milling machine, which seems to be a copy of the Satake rice-milling machine, said that spare parts were fake. Surprisingly, copy spare parts of the copy product are being sold, but it is assumed that there is demand for a good product.

The Tanzanian government has been offering loans primarily to support the large-scale farms who purchased a tractor, even a small financial system for small-scale farmers, such as Saving and Credit Cooperative Society (SACCOS) is also boost. Group loans are available for the purchase of a tiller.

Photo II.1. 14 Puddling with a power tiller (KATC training)

In Lower Moshi Irrigation Scheme, a private sector agricultural machinery rental business, JRT, began operating from 2013. JRT owns 6 tractors, 16 power tillers, and 3 combine harvesters. For 0.3

hectare, tiller hire is 40,000 Tanzanian shillings (about 2,666 yen, 1 yen = 15 Tsh as of January 2015), and the cutting rice crop charge is 100,000 Tsh (about 6,666 yen). Their operation is mainly in the Lower Moshi Irrigation Scheme and surroundings, and is expanded to other regions because there are more competing rental service agencies than they thought. Temporary laborers sometimes travel to the Igunga District in the Tabora Region 500 km or more away for work. Depending on the growing season of crops including maize, temporary laborers traveling outside the region is commonly seen. JRT was funded by the Private Agricultural Sector Support (PASS) that was established in 2000 in Denmark. Japanese company, Seed Africa, has also started rental of tractors and combine harvesters since 2012 in the Morogoro Region and the Mbeya Region. These businesses are expected to improve access to agricultural machinery for farmers, and contribute to the growth of agricultural productivity.

Photo II.1. 15 JRT agricultural machineries for rental

2) Results of Mechanization Feasibility Survey in Kilimanjaro Agricultural Training Center and the Irrigated Rice Fields

In the Lower Moshi Irrigation Scheme of Kilimanjaro Region, Tanzania, with the power tiller as the main focus, a mechanization test was carried out borrowing the irrigation rice fields of KATC and surrounding farms.

(1) Ploughing, Puddling, and Leveling Test

<1> Test method

As preparation activity in the irrigated rice fields, the three procedures of ploughing, puddling, and leveling was conducted each by man and machinery and the results were compared. A power tiller was used for the machinery work, and for the ploughing work, a Japanese moldboard plough or rotovator was used. It was implemented by dividing it into three processing classifications.

The K120 made by Kubota was the power tiller. It is a machinery that introduced KATC with the 2KR. In general, it ploughs and puddles equipped with the ploughing width of 60 cm; however, by taking off the rotovator, it can also be used for moldboard plough.

Regarding the testing classifications, in the Lower Moshi Irrigation Scheme, they use 0.3 ha per section in growing rice, maize, etc., in farm fields. The location borrowed for the test is usually used for irrigated rice, and although the conditions of the paddies do not vary much, in order to create similar conditions such as the overgrowth of weed or the spread of water, the three sections are used, and each of the sections are divided in three as replication to make nine blocks (figure II.1.5).

Regarding the period of the preparation activity, we aimed for the period that is easier to use irrigation water in the Lower Moshi Irrigation Scheme. We implemented the test during the on-site inspection of Friday, August 22 to Saturday, September 27, 2014.

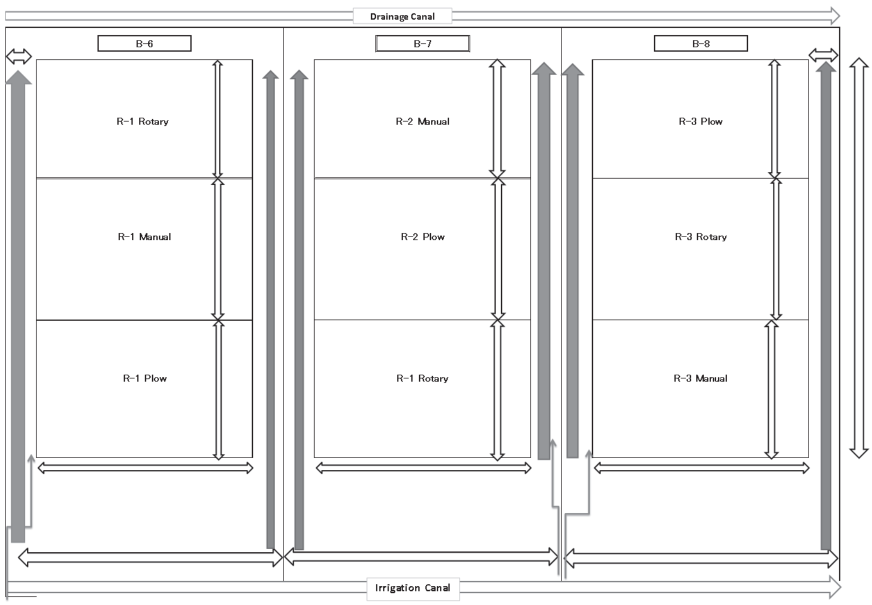


Figure II.1.5. Experimental plots

<2> Test results

(a) Ploughing

This time, two operators were placed. One operator for the ploughing section as the person in charge and a trainee operator were placed in the rotary section. They used hoes in the manpower section, rotary in the rotary section, and a Japanese plough in the ploughing section, and implemented ploughing work.

(b) Puddling

In the manpower section they used their hands and hoes, rotary in the rotary section, and a puddling rake in the ploughing section and implemented puddling work.

(c) Leveling

In between the leveling work between B6 and B8, there was an occurrence of the power tiller being buried. With the proposal of the KATC staff, the rake for leveling was fixed onto the power tiller to continue the work. It was successfully completed.

<3> Observations of the preparation test

In order to conduct the total preparation work (ploughing → puddling → leveling) from Table II.1.3 to the preparation of rice planting of 1 ha, for manpower, if we assume that one day's worth of work is 5 hours (519 hours of total ground leveling work ÷ 5 hours, 1 day's worth of work = 104 days per 1 ha), then the laborer's value per day is 420 yen (7,000 Tsh) × 104 days = 43,680 yen per 1 ha (*1Tsh = 0.06 yen)

On the other hand, using the cultivator, if we set the cost of one cultivator at 500,000 yen and its life time being 2,000 hours, it costs 250 yen per hour of cultivator work. In addition, we expect that repair fees will be the same amount of 250 yen per hour.

The total ground leveling work hours (ploughing → puddling → leveling) of cultivators until rice planting is 37 hours per 1 ha.

Table II.1.3 comparing working time (workload per person/1 hectare)

Time spent on land preparation (plough plot) / hour				
	B6	B7	B8	Average
Ploughing	11.33	20.00	11.67	14.33
Puddling	7.33	6.83	7.83	7.33
Levelling 1	9.17	7.67	8.83	8.56
Levelling 2	6.33		7.17	6.75
	Average time spent on land preparation			36.97
Time spent on land preparation (rotarvator plot) / hour				
	B6	B7	B8	Average
Ploughing	11.67	16.00	11.17	12.94
Puddling	9.00	7.67	8.67	8.44
Levelling 1	6.17	6.83	9.00	7.33
Levelling 2	5.33		8.83	7.08
	Average time spent on land preparation			35.81
Time spent on land preparation (mannual plot) / hour				
	B6	B7	B8	Average
Ploughing	200.00	123.33	88.33	137.22
Puddling	321.67	289.17	293.33	301.39
Levelling 1	40.00	98.33	103.33	80.56
Levelling 2				
	Average time spent on land preparation			519.17

Table II.1.4 fuel consumption

Fuel consumption (plough plot) /ℓ				
	B6	B7	B8	Average
Ploughing		0.90	1.50	1.20
Puddling	1.15	1.00	2.35	1.50
Levelling 1	1.00	1.00	2.00	1.33
Levelling 2	1.00		1.00	1.00
Fuel consumption (rotarvator plot)/ ℓ				
	B6	B7	B8	Average
Ploughing	1.46	0.85	2.45	1.59
Puddling	1.80	1.00	1.75	1.52
Levelling 1	0.90	0.90	1.75	1.18
Levelling 2	0.60		1.00	0.80

※Fuel consumption for plough plot B6 could not measure due to trouble with the fuel tank.
※Rotarvator plot B7 did not need second levelling.
※B8 had heavy clay soil and draining was difficult. Thus ploughing, puddling and levelling were difficult. Wheels got caught in the field and spun. Land preparation got distracted several times. These are the possible causes for higher fuel consumption in this block.

Therefore, the total preparation activity cost per 1 ha until rice planting by a power tiller is: 250 yen for the cost of one hour operation of the power tiller + 250 yen for repair cost × 37 hours of total preparation activity for planting + operation cost (operator cost 6,000 yen + fuel cost 1,320 yen = 7,320 yen) = 25,820 yen. When comparing the total preparation cost per 1 ha between using a power tiller or by man, the expense for using machinery is 17,790 yen cheaper, and there are merits in replacing man with machinery.

In addition, with the inquiring survey this time, regarding the income of farmers, the purchase price of unmilled rice from rice millers is 700-800 Tsh (converted into Japanese yen, it is 42~48 yen *1 Tsh → 0.06 yen), and if we assume that there is a rice harvest of 4 t/ha on average, an income of 168,000 yen per ha is possible.

When one farmer purchases one power tiller, if we set the purchasing cost at 500,000 yen, with the possibility of two seasons of cultivation per year, and if we assume that the number of power tiller repayment years is five years, in devoting 1/3 of the income per ha to the purchase cost (rice income per 1 ha 168,000 × 1/3 × 2 seasons × 5 years), it comes out to 560,000 yen. It is possible to cover the purchasing cost within five years of the repayment years.

On the other hand, regarding the farming area per year in repaying the power tiller cost within 5 years, if we were to calculate that the life time of the power tiller is 2,000 hours ÷ total working hours of 37 hours = 54 ha, it will be 54 ha, the total farming area per year ÷ 5 years of repayment years = 10.8 ha. The average area of irrigated rice a farmer owns is 1 ha/household, therefore the power tiller needs to be used in an area ten times that.

Last year, in a rice field preparation test implemented in the Republic of Uganda, preparation until rice plantation per 1 ha took 35 hours by rotovator and 15 hours by ploughing. There was not much of a difference in the preparation by rotovator with irrigated rice cultivation, but in the ploughing level, it took 2.5 times more time in total working time. When considering the operating time (unit per area), there is more of an advantage in the irrigated rice cultivation than the upland rice cultivation.

In order to increase the farming area, (i) share the use of power tillers, (ii) increase utilization rate by lending power tillers, (iii) use of power tillers other than for ploughing work can be thought of. In general and not just in Africa, there are not many cases where the sharing of agricultural machinery has gone well due to the vagueness of where the responsibility lies and farmers wanting to use the machinery at the same time. Therefore, the combination of (ii) and (iii), and the increase of operation time is realistic.

<4> Impression

At KATC where the test was held this time, the rotovator-type is generally used, therefore it was the first time for the KATC side to conduct each of the work (ploughing, puddling, leveling) using a plough. From KATC staff Mr. Mihayo, who stood by for all of the processes, we received a comment saying the effectiveness of the plough is high.

What came to mind being on site was that all three blocks used as a ploughing testing site this time (B6~B8) [B8 in particular] has extremely hard clay soil, and preparation activity using a power tiller (rotovator and plough) was extremely difficult.

The KATC personnel say they usually do ploughing in irrigated condition, and the reasons why they do it can be understood.

(2) Harvesting Test Results and Rice Millers Survey Results

In the rice fields of Lower Moshi Irrigation Scheme, a harvesting test and survey of rice millers was carried out. The following are the results.

Test period:

November 17, 2014 (Mon) ~ December 16, 2014 (Tue)

Test content:

In the Lower Moshi Irrigation Scheme: (i) Harvest investigation (ii) Interview survey of farms with power tiller (iii) Post-harvest investigation

Test region:

Lower Mosh Irrigation Scheme, farms near KATC

Test results:

<1> Harvesting test

In the irrigation scheme, there are two harvesting methods: (i) Human harvesting using a sickle (ii) Harvesting using a combine harvester. With the cooperation of KADP (Kilimanjaro Agricultural Development Project), we implemented a comparison test from the financial aspect using these two methods.

① Human Harvesting Using a Sickle

In the Lower Moshi Irrigation Scheme, one plot is 100 m × 30 m = 0.3 ha. In this test, one plot was formed as one group of four (the shared working area per person is 25 m × 30 m [0.075 ha]). Harvesting (day 1) → drying (day 2) → threshing (day 3) was conducted, and the income per person was decided by the rice weight at the end of day 3. The breakdown of the average income for a female labor is 5,000 Tsh × 500 kg (5 bags) = 25,000 Tsh (3 days) [1,500 yen, 500 yen per day]. In case of human harvesting using a sickle, 25,000 Tsh per 0.3 ha × 4 people = 100,000 Tsh (6,000 yen). When one worker conducts human harvesting using a sickle on a farm field of 0.3 ha, it takes 24 hours/0.3 ha (6 hours of work per day, and the working hours were from 6:00 to 13:00).

② Harvesting Using a Combine Harvester

The combine harvester used is the KUBOTA DC-60, and the owner is JRT AGRI SERVICES (the purchase price of the combine harvester hiring service company in Moshi is US $42,500). The harvesting fee was 100,000 Tsh (6,000 yen) per 0.3 ha, and the working time was approximately 45 minutes.

As for the advantages when harvesting with a combine harvester, the working time is short, and it can do threshing work. At the site where we conducted our survey, the cutting height was set high. The rice plant was approximately 90 cm, and the remaining plant after harvesting with a combine harvester was 20 cm. The remaining plant when human harvesting using a sickle was 7 cm. As merits for setting the cutting height high, there is less rice straw residue and the efficiency of threshing increases. In addition, the cutting speed is fast, and it is possible to save time during the mowing process. As for demerits, since the cutting height is high, there is a lot of straw residue, and the preparation for the next season takes effort. In order to work by setting the cutting height lower, the leveling of the rice field is necessary. If the harvesting is not carried out while the field is not leveled well, the blade of the combine harvester is damaged by hitting the soil.

The advantages of cutting by hand are that the cutting height is low, and it takes less effort for the preparation of the next season.

In the irrigated rice field of Lower Moshi Irrigation Scheme where the drainage conditions are poor, the moisture of the rice straw is high, which leads to difficult threshing. There is no choice but to raise the cutting height.

In the farm fields where harvesting using a combine harvester is carried out, cows were grazed to take care of the remaining plant. By first ploughing and processing the remaining plant, it prevents the survival of pests onto the next season.

③ From the Investigation Results

The amount it costs to harvest with humans using sickles and harvest using a combine harvester is the same at 6,000 yen per 0.3 ha, harvesting with a combine harvester takes less time, and there is the large merit of being able to harvest at the proper time. Even in the farming areas of Tanzania, the outflow of young people going into the city is unavoidable, and it is difficult to secure adequate workers during the harvest season. The acquisition price of a combine is expensive at US $42,000, however, from a harvest agency, the harvest surely becomes cash income (payment by goods in some cases), and it is believed that the installation of combines will further increase.

Since it operates during a limited period of time, if the machine is broken at the time and unusable, it is a big blow for the harvesting agency. In the Lower Moshi District, even though the Japanese manufactured machines are slightly more expensive than the Chinese manufactured machines, the more reliable Japanese manufactured machines are more popular. And the replacement into Japanese machines from Chinese machines is progressing (with this point, the quick supply of parts is important).

<2>Inquiry survey of farms with power tiller

The opinion that was raised from farmers who own power tiller was that Japanese branded machinery are easier to use, but obtaining spare parts is difficult. Regarding the Chinese manufactured machinery, the evaluation was that the price is cheaper at large, but it breaks easier.

As a reason for the occurrence of a difference in the price of hiring service, the machinery gets stuck in the dirt in the paddies with bad drainage which leads to more consumption of fuel. There were responses saying the price changes according to the condition of the soil.

Table II.1.5 Price list of purchase power tiller (interview from farmer in KATC, Tsh, 1Tsh＝0.06 Yen)

Power tiller	Price (purchase)	Price (service /acre)	Income by service (/acre)
Chinese-made	3,000,000	100,000	40,000
KUBOTA K125	9,000,000	70,000	15,000
ISEKI AGRIND KAI 711	7,000,000		
ISEKI AGRIND KAI 711	4,000,000	70,000	15,000～20,000
ISEKI AGRIND KAI 711	4,900,000	70,000	15,000～20,000
KUBOTA K125	2,500,000		
KUBOTA K125	2,500,000	150,000	80,000
YANMAR HS8-KE	2,000,000	80,000～90,000	30,000
KUBOTA K125	2,500,000		
KUBOTA K125	2,500,000	70,000～80,000	25,000
Chinese-made(broken)	2,500,000		
Chinese-made	1,500,000	60,000～80,000	40,000

<3>Post-harvest interview survey

(1) About the Post-harvest Process at Farms

In the Irrigation Scheme, the threshing and drying is conducted on a vinyl sheet, but since workers step on the vinyl sheet with dirt on their shoes, impurities such as pebbles mix easier. Taking out pebbles is an issue.

(2) About Rice Miller

At all of the ten rice millers (Table 2-2) we investigated, the Chinese manufactured Satake copied product SB-50 was being used. The cost of milling rice was 30~45 Tsh/kg. In comparison, the milling price was cheaper at large rice miller. There are cases of the middlemen making the purchase at rice miller, or the farmer taking back the rice after milling and selling it at the market on their own.

As for the drying process at a rice miller, it is dried spending 1~2 days (adjusted depending on the weather). Since there are no moisture meters, the methods of measuring the moisture content that were raised are crush with teeth a rice grain, crushing the rice by hand, or stepping on the rice. (When measuring the moisture content of rice after drying at one of the rice mills, it was 12%. It is slightly more dry than the adequate moisture content of 14%). There are many blackouts, and there were lots of rice miller not being able to function with the lack of electricity. There was a rice miller owner who want to buy a drying machine for rice. According to him, it is difficult to make adjustments to the dryness especially during the rainy season when drying with sunlight.

(3) About Distribution/Market

In shipping out the rice to the market after milling, trading in a 50 kg bag is the main stream (at the farm field level, 100 kg per bag). And the distributed brand we were able to see this time at the rice miller and local market was the Saro 5 (1,200 Tsh/kg) [it is a fragrant rice, and it was being traded at a higher price than the IR64]. There were comments saying the Tanzanians prefer the aromatic rice (there is also a tendency in Uganda preferring aromatic rice). The IR64 (1,100 Tsh/kg) [it seems like it is being called “Japanese” at the market], Mubeya rice (1,300 TZS/kg), Magugu rice (name of the place about a five hour drive from Arusha) [1,600 Tsh/kg], and other rice with names of the local region were also being distributed (the breed is unknown). At another store, the price of Mubeya rice was separated by 1,900 Tsh/kg, 1,700 Tsh/kg, and 1,600 Tsh/kg, and as points for the difference in the price, the price changes according to: ①Aroma ②Taste ③Ratio of mixed impurities such as small stone. In the local market, maize grains (900 Tsh/kg) and maize powder (1,000 Tsh/kg) was being sold. At the supermarket of Moshi (Nakumatt), the Magugu rice was packaged nicely, and it was sold at 4,500 Tsh /kg, which is approximately three times the price of the local market.

At Masawe Machine, which is one of the rice miller of Moshi town, I was able to see a grader (rice sorting machine). They say it undergoes rice sorting at 300 Tsh/50 kg, and the demand in the needs of sales with added value in rice can be seen.

(4) Others

① Regarding rice straw, there was a trader who came out to the farm field to buy them in a truck. This time, the trader we tracked and investigated was transporting rice straw to a banana farm approximately 50 km away one way. In a 3t truck, the transportation fee including the purchase cost was 200,000 Tsh (12,000 yen). The banana farm was using the ethylene gas from the rice straw for maturing (it is also used for avocados with the same purpose). In addition, the rice straw is for animal food.

② In harvesting using a combine harvester, 5-10 kg of gleanings arise per one section of 0.3 ha. In addition, even with threshing by humans, approximately the same amount of rice remains. The loss post-harvest is quite large, and there is room for improvement.

	Milling Price (Tzs/kg)	Packing bag (Tzs)	Selling price of milled rice	Selling price of rice bran
①Indian SAI Rice Milling	34	500		
②New Kinana Millers	35			5,000Tzs/50kg
③Clot Milling Macine	45		IR64 55,000Tzs/50kg	
			SARO 60,000Tzs/50kg	
④Milling at Churches	45	600		
⑤VICAKILI Investment	45	500		5,000Tzs/50kg
⑥Mama Teddy Machine	40	500	SARO 60,000Tzs～65,000Tzs/50kg	
⑦Kaumba Milling	35	500	IR64 55,000Tzs/50kg	
			SARO 60,000Tzs/50kg	
⑧Masawa Machine	30	400	IR64 50,000Tzs/50kg	
			SARO 65,000Tzs/50kg	
⑨RDIHIONE	34	450	IR64 50,000Tzs/50kg	5,000Tzs/50kg
			SARO 60,000Tzs/50kg	
⑩Tara Milling Center	40	400	SARO 60,000Tzs/50kg	7,000Tzs/50kg

TableII.1.6 Rice milling price in Moshi area (1Tsh＝0.06Yen)

3) Rice cultivation and the mechanization of agriculture in the Mbeya Region

(1) Rice cultivation in Mbeya Region

The Mbeya Region is one of 30 administrative areas in Tanzania, and is situated in the south west. It has a total area of 62,420 km^2 and is divided into 10 administrative districts. It has a population of 2.7 million (2012), and there is 850 km of fully paved roads from Mbeya to Dar es Salaam. Additionally, it is located on the national border with a rail line running between Tanzania and Zambia and a main road running between Zambia and Malawi, with 100km each way to Zambia and Malawi. The Mbeya Region has a high food self-sufficiency rate at 141%, following the Rukwa Region at 179%, the Ruvum Region at 158%, and the Iringa Region at 145%, and largely contributes to the food security of Tanzania.

Table II.1.6 Primary Crops and Yields of the Mbeya Region (2011)

Crop	Cultivation Area (thousands of hectares)	Total Yield (thousands of metric tons)	Harvest Yield per Hectare (tons)
Maize	368	662	1.8
Paddy	69	242	3.5
Potatoes	68	143	2.1
Pulses	54	60	1.1
Banana	30	65	2.2
Millets	17	17	1.0

Source: Developing the rice industry in Africa, Tanzania assessment July 2012

The Tanzanian Government is promoting a project known as 'Big Result Now'. In the agricultural sector, the priority crops at ①rice, ②maize, ③sugarcane. The average harvest yield for rice is currently at 4 tons/ha, but they have established a goal of 8 tons/ha for the future. To accomplish the goals of this project, 78 locations have been selected for an irrigation scheme in the country, and 36 of these are located in the Mbeya Region (34 in Mbarali District and 2 in Kyela District).

(2) Current state of rice cultivation

The Mbeya region has the third highest rate of rough rice production in the country (Tabora Region is #1 and Morogoro Region is #2), and is a priority rice cultivation area in the SAGCOT Program. The rainy season stretches from November to April, and around 800mm of rain falls during this time. The SARO5 variety accounts for 50% of all rough rice volume, and other varieties native to Zambia and Kilombero are also cultivated.

The Madibira Agricultural Marketing Cooperative Society (MAMCOS) of the Mbarali District transplants 90% and direct sows 10% of their rice, and they plough with disk harrows and till with rotovator. The recommended planting time for seedlings is at 21-30 days old, but due to a lack of labor, 50-70 day olds are sometimes planted. The varieties SARO5 and Faydome are cultivated. Kyela District distributes its rice as Kyela rice. Most fields are rain-fed in this region, and 70% are direct sown at a small scale of 0.4ha of cultivation area per household.

Table II.1.6 Primary Rice Cultivation Area and Production Amount by Each District in the Mbeya Region (2009)

District	Cultivation Area (thousands of hectares)	Total Yield (thousands of metric tons)	Harvest Yield per Hectare (tons)
Mbarali	39	151	3.9
Kyela	18	53	2.9
Mbozi	10	27	2.7
Chunya	9	13	1.4

Source: Developing the rice industry in Africa, Tanzania assessment July 2012

(3) Current state of the mechanization of agriculture

<1> Field Preparation (Irrigated rice [transplanting] and Rainfed rice [direct sowing])

Ploughing in irrigated wet paddies requires the use of disk ploughs with both tractors (50-100 hp) and power tiller (14 hp). After ploughing, the field is flooded and tilling is performed with a rotovator. Tilling is performed by agitating the cage wheels at high speed, since a rotary/ rotovator is not attached to the traction-type power tiller. On the other hand, some areas run the rotovator without ploughing and while the field is flooded, and then carry out immediate planting.

Additionally, the power tiller widely used in the Mbeya Region differs from the rotovator-type power tiller widely used in the Kilimanjaro Region, in that there are no rotary blade, and the power tiller is a traction-type which ploughs up the field by towing the plough. Ploughing in flooding condition is standard with the rotovator-type, but by ploughing a dry condition with a traction-type, irrigation water can be conserved and work can begin before the irrigation water arrives, and this allows for a longer work period.

In direct sowing, the field is ploughed by disk, the soil is crushed by harrow and after the pre-soaked seeds have been broadcasted, they are then covered with soil by harrow.

Irrigated rice fields run on low ground along river systems, and there is a lot of clay soils which tend to fissure in the dry season. Therefore, ploughing is done using a large tractor with disk harrows attached. When using a power tiller, the farmers will wait for rainfall and they will use disk plough in the field when they feel that the soil has absorbed enough moisture. The power tiller tire size is one measure larger than Japanese standards at 7.5-16 inches (normally 6.0-12, 5.0-13 inches) (Same size is used in Tanzania on Kubota in Thailand machinery and Chinese-made machinery). The reason for this is that the ground of cultivated fields is rough, and a higher chassis is more of an advantage. However, driving at speed of 25 km/h on public roads with these large-size tires leads to numerous accidents. Power tillers are used primarily for transport (production, such as rough rice and vegetables, construction materials and laborers). Transportation is a quick way to earn cash, and many Power tillers can be seen towing trailers beginning early in the morning. The regional administrative officials have indicated that there is a need to provide farmers with information and instructions since they are not being used for multiple purposes, such as for irrigating pumps or rice threshing. A lack of spare parts is owing to the abilities of dealers and the understanding of agricultural tools. Whether a company has a surplus of inventory, deals with agricultural tools, or has experience or owns retail dealers in other regions—put differently, if they are large and financially strong—makes them influential. However, large companies like this handle a wide variety of products, such as automobiles, construction equipment, farm equipment and office equipment, and so cannot adequately respond to the situation. The Japanese side must periodically tour the region to better our understanding, and work to educate local technicians.

<2> Leasing Service of Tractors/Combines

There is significant leasing being done with 4 wheels-tractors, power tillers and combines harvesters. There are differences in lease amounts by location, but the ploughing fee for a tractor per hectare is around 170,000 Tsh and a rotovator is 150,000 Tsh. A power tiller fee is generally 10 to 20% less expensive than the tractor fee. The combine harvester fee is 350,000 to 400,000 Tsh for a large machine and around 300,000 Tsh for a small machine. Incidentally, harvesting by hand is 200,000 Tsh (15 people x 2 days x 6,000 Tsh, including threshing).

However, there is a shortage of tractors and combines in absolute numbers, and this can lead to missing the best work season. In the case of MAMCOS in Madibira, an individual operating 8 to 9 combine harvester needs three months to work 3,000 hectares.

Beginning this year, Seed Africa (a leasing company run by Japanese) has introduced a Japanese-made combine harvester and is harvesting with it. The leasing fee is paid in cash (there are cases where it is paid in rice), and it is earning a profit. On the other hand, fee ploughing by hiring service was also being done by tractor and power tiller, but since there are few farmers with enough cash to pay in advance, they withdrew from this business. Spare parts are available with regular expendable supplies, but there are many breakdowns since the operators don't have the technical capacity and there are no farm roads and they must cross canals or the ridges between the rice fields to reach the field to harvest. Thus, there are also unforeseen breakages of parts. Seed Africa runs combines for around three months, and improving their efficiency is a current issue the company faces.

Table II.1.7 Status of the Introduction of Equipment to Mbarali

Cultivation Area (hectares)	By hand	By draught animal	By tractor (large/small)
158,000	15,800 ha (10%)	28,914 ha (18.3%)	113,286 ha (71.7%)

Source: Mbarali District Administrative Bureau

(4) Rice milling

There are 22 small-scale rice milling plants at the SIDO rice milling cluster in Mbeya Region, and there is a rice milling complex where 15 small-scale rice miller gather in Mbarali District (100 km from center of Mbeya). There is also a medium-size (2 to 3 tons/hr) rice milling plant (Buehler-made) run by an Tanzanian of Indian heritage, as well as traders (Raphael Group Ltd. with two 1-ton/hr plants, Mtenda Kyela Rice Supply Co., Ltd. with one 1-ton/hr plant). In the main rice-producing region of Mbarali District, there are 300 small-size rice milling plants, 14 medium-size rice milling plants, and three large-size rice milling plants within an estate. Most of rice production (paddy) is processed at small and medium-sized rice milling plants, but there are numerous rice millers and their market is high competitive. A medium-size rice milling plant is made up of a feeder, a de-stoner, a one-pass (SB-50), a rice sorter, a rice milling machine (friction-type), and a shifter (there are four types of outlet). Perfect grains and three quarters grains are mixed in the bagging process; but, since there is no stone de-stoner in the final process, stones inevitability get mixed in with the milled rice. 80% is piecework where either 1) the rice is brought in by the traders and milled, or 2) the rice is brought in by the farmers, milled and sold to the traders. There are no graders or de-stoners.

The SB-50 (Chinese-made) with 500 to 800kg/hour accounts for most of the rice milling machine held by small-size rice miller. The fee for hulling and polishing rice is 45 Tsh/kg of rough rice.

There is a recent trend to sell at a high price aromatic rice with a luster and no stones or other foreign objects, with a cracked rice content of 20%, and for highly-polished rice to be favored. SARO5 has a high yield rate, but there tends to be chalky grains, and when the harvest is late, the husks can crack. Thus, there are some regions that are averse to this variety. Native varieties (Zambia, Kilombero) are considered high-quality rice, and while they have low yields, they are drought resistant and are known to have a pleasant aroma. There are also rice miller (Chimala) who only deal in native varieties.

(5) Small industry development organization

The Small Industry Development Organization (SIDO) is a public company under the auspices of the Ministry of Industry, Trade and Marketing, and they have regional offices in 21 locations across the country. Apart from training human resources and working to improve policy for small and medium-size manufacturers, they are also working on infrastructure maintenance, industrial clusters and financial assistance.

Rice milling Industrial Clusters

SIDO Mbeya Branch built an industrial park, and currently runs 22 small-size rice miller and a sunflower oil extractor in one location. Behind the integration of them into one location were the previous problems that accompanied operating a rice milling business in an urban center, such as causing traffic jams during the times the rice was loaded and unloaded, as well as complaints from neighboring residents about the garbage and dust pollution. Thus, SIDO borrowed land from the national government, solicited for operators to participate and carried out loans of zoned land and financing. However, since the financial assistance provided by SIDO comes in small sums (200 USD, 350 USD per person when in groups), most of them receive financing from banks.

Rice bran is sold at 5,000 Tsh per 100kg bag as livestock feed. However, the disposal of the rice husks is becoming a problem. Currently, brick makers and cement factories will come pick them up, but most are disposed of. The Embassy of Japan is examining rice husk fuel and preparing to advance a project on this.

The problems of the rice milling cluster are 1) marketing, with exporting (the quality is not up to world standards) difficult, 2) rice miller do not have capital (they cannot buy paddy rice, therefore they do only piecework processing), 3) rice husk disposal.

SIDO is currently envisioning similar industrial parks in two locations in the future and is planning their construction.

Photo II.1.16 Rice being received

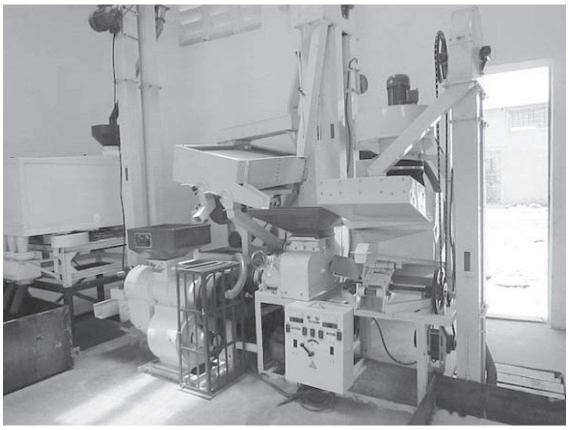


Photo II.1.17 Chinese-made Rice Milling Plant

(6) Price of rice

Rice that is aromatic, has luster and 20% cracked rice content is traded as high-quality rice, and the price of rice is branded based on the region it was produced in. Kamsari rice goes for 55,000 Tsh per 91kgs, Mbarali rice goes for 80,000 Tsh per 160kg (500 Tsh/kg), and the native varieties (Fay dome) goes for 70,000 Tsh per 100kg. The price of rice peaks from October to April, sometimes reaching 2.5 times the price during the harvest season. The administrative governments are promoting the construction of warehouses, but they don't function. Currently there are warehouses in 18 locations (7 cooperative, 11 village) in the Mbarali District.

The Government bought 5,000 tons of MAMCOS rough rice at 65,000 Tsh through the food security policy, and this rice is stored in a government-owned warehouse.

As we have written previously, it is the farmer's decision to choose the high-yield, improved-variety SARO5, or to select the native variety which has a low yield, but is traded for a higher price. However, there are draw backs to the SARO5, such as the need for irrigated rice fields, and the large material investment, such as with fertilizer, and an unstable price (cracked rice, white-based kernels), and there are some regions averse to planting this variety.

Table II.1.8 Comparison of Native Verities and Improved Varieties

Variety	Harvest Amount (ton/ha)	Paddy Rice Unit Price (Tsh/kg)	Gross Income (Tsh)	Variety Features
Improved Variety (SARO5)	5	500-600	2,500,000-3,000,000	Semi aromatic, requires irrigation and input of materials
Native Variety	1.5	700	1,050,000	Highly aromatic, has luster, drought-resistant, growth period 120-130 days

Source: Interviews by Survey Group

(7) Current state of MAMCOS Madibira Irrigation Scheme in the Mbeya Region

MAMCOS (Madibira Agricultural Marketing Cooperative System)

This is a rice cultivation irrigation scheme set up by an English consultant and a South African construction company in 1997 through funding from the Tanzanian Government and the Africa Development Bank. It is run with 3,000 hectares of cultivated land and 3,300 personnel. The 3,000 hectare irrigation scheme is set up in partitioned 30-hectare blocks, and (member) farmers borrow 1 hectare each. The annual expenses are 135,000 Tsh (water fees, canal maintenance, management costs etc.) and within this 5,000 Tsh is allocated to canal repair. Each year, surfacing is done on three faces of the main canal (approx. 150m) with money from the reserve fund. The soil is silt clay and is ploughed between November and December, it is cultivated with a rotovator in January and February, and the harvest takes place from May to July.

MAMCOS owns one tractor (90-110hp) and one Kubota combine harvester. There are privately-owned tractors (5 working among 48 large and medium-size; 200 working among 300 power tillers). There are 7 to 8 combine harvesters, and an external leasing agent manages the sales of these.

Ploughing is done by disk harrow, and a rotovator tills before planting. Planting is under a service contract and random planting is done.

To secure planting laborers, they go to laborer gathering points early and recruit there. There are sometimes no workers available if they are late to arrive at the gathering points. Ultimately, rice seedlings grow spindly and transplanting is late. Laborers must be transported to the fields, and trailers and vehicles are required to bring 10-15 laborers several kilometers.

There is rice milling equipment (German-made Schule 3-4 tons/hour), but it does not operate due to a lack of electricity. It can be run from a generator, but fuel costs are prohibitively high (Power to be supplied this year).

The warehouse cannot be run because there was corruption with the previous manager, and the warehouse is currently shutdown.

Table II.1.9 Costs of Rice Plant Cultivation

Required Work/Materials	Expenses (Tsh)
Cost of Seeds	60,000
Plowing (tractor)	150,000
Tilling (harrow)	150,000
Transplanting (outside laborers)	150,000
Weeding (outside laborers)	150,000
Fertilizer (Urea,DAP)	200,000
Harvesting/Threshing (combine harvester)	320,000
Transport (tractor)	150,000
Bird scaring	60,000
Sacks	50,000
Total Expenditure	1,440,000
Rice Yield (kg/ha, paddy)	5,000
Rice Price (Tsh/kg, paddy)	600
Total Income (Tsh)	3,000,000
Total Expenditure (Tsh)	1,440,000
Net Profit (Tsh)	1,560,000

Source: interviews by Survey Group from MAMCOS (Oct 2014)
$1 US = 1,700 Tsh

(8) Future plans and issues for the Madibira Irrigation Scheme by MAMCOS

① There are plans to build a dam further upstream and expand the irrigation scheme to 3,600 hectares.

② They wish to bring in KADP design and implementation technology to this scheme; specifically, the installation of agricultural roads, appropriate partitioning of fields (partitioning of existing fields with a 1-hectare average is difficult), canal lining is required.

③ Under the existing scheme, transporting harvested produce and workers a total of 15km is too far (additional transport fees arise). Workers camp together, and they wish to secure a camp space which would shorten travel times and make operations more efficient.

④ They plan to change from transplanting to direct sowing (mechanized). They wish to try fertilizing trials and direct sowing trials.

Photo II.1.18 lining work on a canal built from reserve

Photo II.1.19 30 hectares cultivated field

(9) Traders / middleman

Large-scale farms have their own sales network; however, there are large traders (the two companies below) that mill, bag and sell the rough rice collected from small-scale farmers.

① Raphael Group Ltd.

They are a large trader that deals with rice, peanuts (hand-selected), and sunflower oil, and they handle 20,000 tons of paddy rice annually. A regional manager is sent to the production area to distribute seed and supervise. They own two rice milling plants (Chinese made) that handle 2 tons/hour, and they sell Raphael-brand rice in the capital and surrounding cities. They have participating partners—a fertilizer company (Year) and a seed company (Tan-seed).

② Mtanda Kyela Rice Supply Co., Ltd.

They loan agricultural materials to and purchase paddy rice primarily from Kyela, and they mill and sell rice. Currently, they are expanding their business aimed at small-scale farmers, by loaning out agricultural materials to other regions and dispatching technical advisers. They have 10,500 farmers currently under contract. They have participating partners—a fertilizer company (Yara) and a seed company (Tan-seed International). They are planning the purchase of a Chinese-made rice milling plant.

Photo II.1.20 Raphael rice polishing plant (2 tons/ha)

Photo II.1.21 Raphael product

Table II.1.10 Main Varieties and Features of Mbeya Region Rice

Variety	Cultivation Period	Features
Supa	140 days	Native variety, good tasting, popular with local farmers
Soro5 (TXD306)	120 days	Semi-aromatic rice produced through a cross of Super and Korian Subrimati, high yield with 30-50 tillers (4-6.5tons/ha)
Nerica	90 - 100 days	Highly drought resistant, taste not optimum
IR-64	100 days	Indica type, high harvest yield
Zambia		Traded as a higher-end rice than SARO5, has a luster with harvest yields 1/3 of SARO5
India		Native variety, good tasting, popular with local farmers
Kilombero		Native variety, good tasting, popular with local farmers
Faya dume	125−130 days	Native variety, good tasting, popular with local farmers, little cracking, growing period 15 days shorter than SARO5

Table II.1.10 Fuel Prices (Tanzania, Tsh/L)

Fuel	Mbeya	Madibira
Gasoline	2,299	2,450
Diesel	2,171	2,250
Kerosene	2,122	

5) Tanzania agricultural policy and Southern Agriculture Growth Corridor (SAGCOT)

Tanzania national agricultural policy[3] comprises Tanzania Development Vision (TDV), Poverty Reduction Strategy Paper: PRSP, National Strategy for Growth and Reduction of Poverty (NSGRP I & NSGRP II), the Long-term Perspective Plan, and the Five Year Development Plan. This comprehensive policy framework aims to improve living standards by making agriculture more efficient, modern and commercially-viable. To accomplish this, there are various initiatives being taken, such as the Kilimo Kwanza Resolve, the Tanzania Food Security Investment Plan (TAFSIP), the Southern Agriculture Growth Corridor of Tanzania (SAGCOT), the Feed the Future Programme, and the Bread Basket Initiative. Among these is SAGCOT—which assists in the promotion of agribusiness through public-private partnerships and is calling for large-scale agricultural investment—an institution which is expected to achieve results.

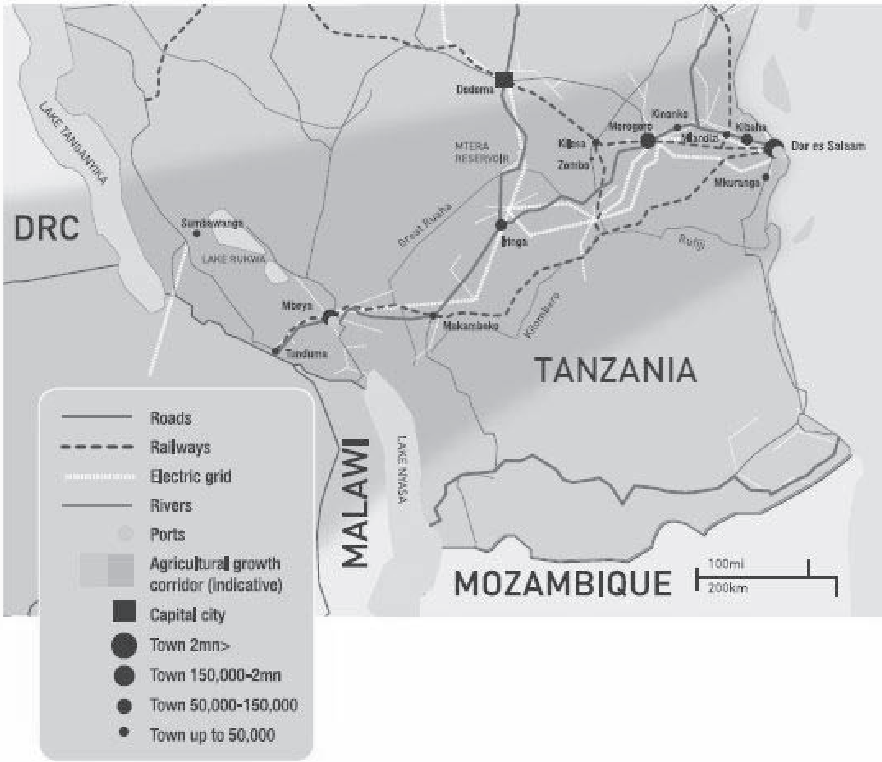
SAGCOT is a national-level framework project formulated by the Tanzanian Government in partnership with the private sector. The project began at the Africa Summit of the World Economic Forum in 2010 for the chief purpose of improving agricultural productivity. The project blue print was subsequently shown by Prime Minister Mizengo Pinda, and it was internationally announced at the World Economic Forum held in Davos by President Jakaya Kikwete. The project targets a region stretching from Dar es Salaam to neighboring Zambia, Malawi and the Democratic Republic of Congo (Figure II.1.6), and large-scale agricultural investment is being planned and carried out in each area.

SAGCOT will achieve improvements in living standards and agricultural productivity by harnessing the resources of governments, businesses, donors and farming communities, and will benefit small-scale regional farmers and make possible environmentally-friendly sustainable development through the comprehensive and commercial development of agribusiness.

The planning behind this project was done by the executive committee Kilimo Kwanza Growth Corridors, which is jointly headed by the Tanzanian Minister of Agriculture and the Vice-President of Unilever North/Central Africa. Apart from the committee, partners to the Kilimo Kwanza Growth Corridors and a SAGCOT technical team were also involved in the planning. The committee, partners and technical team members appear as shown in Table II.1.11.

[3] National Agriculture Policy, Ministry of Agriculture Food Security and Cooperatives, Oct 2013

Figure II.1.6 Target Region for SAGCOT



Source: Southern Agricultural Growth Corridor of Tanzania Investment Blueprint, 2011

Table II.1.11Planning Members of SAGCOT

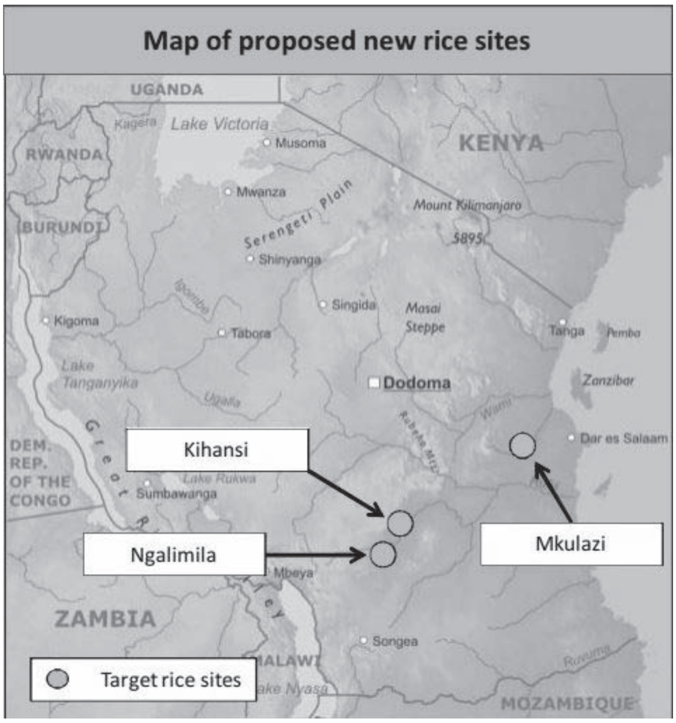
Kilimo Kwanza Growth Corridors Executive Committee	
• Government of Tanzania • Unilever • Yara International • Agricultural Council of Tanzania (ACT) • Alliance for a Green Revolution in Africa (AGRA)	• Confederation of Tanzanian Industries (CTI) • Tanzania Sugarcane Growers Association • United States Agency for International Development (USAID) • Irish Embassy –Tanzania
Kilimo Kwanza Growth Corridors (other) partners	
• Diageo • DuPont • General Mills • Monsanto • SAB Miller • Syngenta	• Standard Bank (Stanbic) • National Microfinance Bank • Norfund • Norwegian Embassy – Tanzania • Food and Agriculture Organisation (FAO) • The World Economic Forum
SAGCOT Technical Team	
• AgDevCo (co-lead) • Centre for Sustainable Development Initiatives (CSDI) • Korongo • Logistics Consulting Group • Prorustica (co-lead) • Tanzania Agricultural Partnership	

Source: Southern Agricultural Growth Corridor of Tanzania Investment Blueprint, 2011

As Table II.1.11 shows, not only was the Tanzanian Government and private companies involved, but there were various country donors also involved in the planning and who expressed support. This began in May 2012—three years after the L'Aquilla Food Security Initiative (AFSI) was expressed at the G8 Summit held in L'Aquilla, Italy in 2009—with The New Alliance for Food Security and Nutrition formulated at the G8 Summit held in Camp David in the US. The G8 leaders expressed their support for eliminating hunger across all of Africa. The highest goal of the New Alliance is to bring 50 million people out of poverty in 10 years by improving agricultural productivity and farmers' incomes through the use of sustained civil investment and ownership by the governments of the countries of Africa. With SAGCOT already functioning to aid Tanzania in the main target areas to achieve this initiative, the G8 has expressed their support for SAGCOT.

In the SAGCOT target regions, there are calls for investment in the production of sugarcane and maize, and the SAGCOT Investment Partnership Program is being formulated for these important crops. A Partnership Program is also being created by the Tanzanian Government through an Agricultural Sector Develop Programme (ASDP[4]) for rice, an important crop along with maize, and three sites have been secured for this program as rice production sites (Figure II.1.7).

Figure II.1.7 SAGCOT Rice Production Sites



Source: SAGCOT Investment Partnership Program – Opportunities for investors in the Rice Sector, October 2012

4 SAGCOT Investment Partnership Program- Opportunities for Investors in the Rice Sector, October 2012

These regions have been selected based on their ideal natural conditions for agriculture and their access to markets. An overview of each of these regions is as follows.

<1> Ngalimila site

① 5,128 hectares of land earmarked by the government for rice production
② 6.5 hectares of land earmarked for sleeping quarters, offices and storage facilities
③ Surrounded by three rivers (Mpanga, Mnyera, and Ruhudji) it has potential for the development of irrigation
④ The land is flat and there are vertisol and fluvisol soils
⑤ There are 3,900 households living in Ngalimila village, where the site is located, and not only will a labor force be expected, there is also potential for surrounding producers (outgrowers)
⑥ It is located 35km from the TAZARA rail line linking Dar es Salaam with the Zambian border

<2> Kihansi site

① 5,200 hectares of land earmarked by the Tanzanian Government (divided into four blocks)
② Located along the Kihansi river with potential for irrigation development
③ The land is flat and there are vertisol and fluvisol soils
④ It is surrounded by four other villages, and not only will a labor force be expected, there is also potential for surrounding producers (outgrowers)
⑤ It is located close to the TAZARA rail line linking Dar es Salaam with the Zambian border

<3> Mkulazi site

① 63,000 hectares of land earmarked for rice production, however, since no investment plan has been established, it is being surveyed with plans for it to be divided into several parcels for re-promotion to investors
② Surrounded by four rivers
③ The land is flat and there are vertisol and fluvisol soils
④ It is surrounded by several villages, and not only will a labor force be expected, there is also potential for surrounding producers (outgrowers)
⑤ It is located around 50km from a paved road linking Dar es Salaam with Morogoro

As investment in rice production is being promoted, the SAGCOT Investment Partnership Program has compiled a revenue and expenditure forecast, as shown in Table II.1.12, when investing in rice production.

Table II.1.12 Revenue and Expenditure Forecast Investing in Rice Production in the SAGCOT Investment Partnership Program

Revenue	
Yield	Current commercial farmers harvest 3.5 tons/ha with rain-fed cultivation; however, introducing irrigation is expected to increase this yield to 10 tons/ha.
Rice Price	The price of rice in the East African Community is 75% higher than the international price owing to import tariffs.
Expenditure	
Labor Costs	Labor costs for agricultural laborers are approximately $180 US per month (including housing allowances and various taxes).
Land Price	After the land owner has been initially compensated, it is $1 US per hectare annually.
Farming Input	There are tax exemption measures taken on farming inputs (capital, fertilizer etc.) by qualified investors.
Training of Surrounding Producers	Donors and NGO programs support the training and farm input of outgrowers.
Taxes	Corporate tax is 30%, and import tariffs and added-value taxes are exempt.

Source: SAGCOT Investment Partnership Program – Opportunities for investors in the Rice Sector, October 2012

In addition to investment programs from Switzerland and the US already permeating these areas, assistance institutions and microfinance institutions are helping small farmers to organize. There is also progress on infrastructure, such as the construction of roads and dams.

The development of the SAGCOT target regions is progressing in a variety of forms. Regional small farmers are being afforded opportunities to participate in agribusiness as laborers and outgrowers, and the further future expansion of this is gaining attention.

5) Tanzania agricultural finance

A major issue in Tanzania financial services is the limited access of farmers to those services. According to the Agriculture Finance Markets Scoping Survey (AgFiMS)[5] carried out in 2011, there was access to formal financial services by only 168,000 businesses, or about 32.4% of the 519,450 total businesses carrying out small and medium-sized farming[6]. 13.3% have access to informal financial services, and the majority at 54.3% do not have access to financial services. (Break down is as appears on Table II.1.13)

5 From the National Financial Inclusion Framework (AgFiMS) (based on contents of AgFiMS study)

6 Among the producers, processors and service providers involved in agribusiness, Small and Medium Agri-Business (SMEs) are defined as those individuals who gain a profit of $600 per year on 5 acres of land.

Table II.1.13 Breakdown of Financial Services[7]

Use of Formal Financial Services	・Use of financial institutions with formal licensing ・Banks, Mobile Money, MFI[8], SACCOS[9] etc.
Use of Informal Financial Services	・Use of Institutions and Groups without formal licensing ・Savings, Loan Groups, ROSCAS[10] etc.
No Access	・No use of any form of financial service

Additionally, there is only extremely restricted access to banks by individual farmers. According to FinScope Tanzania 2013[11], the segments with the easiest access to banks are those income earners who live in cities, and 78.6% of formally-employed people use banks. With 19.6% of self-employed people, 7.1% of agribusiness workers, and 4.9% of subsistence farmers using banks, it is clear that farmers have markedly low access to banks.

The impeding factors for workers in the agribusiness sector using banks were apparent in the answers given for why they do not use banks: their income is too low to have a bank account, they cannot maintain the minimum bank account balance, the banks are too far etc[12]. From the perspective of the banks who provide the financial services, there is significant risk in agriculture, which is easily affected by the weather, the farmers have low financial literacy and there is little ability to create a business plan that will examine how the loan will be paid back. Regarding financial literacy, there are numerous cases where basic information had to be taught to the farmers, such as that any financing received must be paid back and that interest would accrue[13].

Among farmers who cannot have access to banks, the individuals who access formal financial services are thought to use MFI or SACCOS. As is shown in Table II.1.14, among the formal financial institutions, SACCOS has the most amount of financial institutions and access points, and according to a study by the World Bank[14], the majority of SACCOS users are located in farming areas, and 25% of individuals who receive formal financial services, or 1,153,248, use SACCOS. This is an important institution for farmers to gain access to financial services.

7 From the National Financial Inclusion Framework, Tanzania National Council for Financial Inclusion
8 Microfinance Institutions
9 Savings and Credit Cooperatives Society
10 Rotation Savings and Credit Associations
11 http://www.fsdt.or.tz/finscope/sites/default/files/pdfs/FinScope-Brochure-2013.pdf
12 From the FinScope Tanzania 2013
13 From the interview with the author (October 2014, CRDB Micro-Finance Bank and Tanzania Investment Bank)
14 Tanzania Diagnostic Review of Consumer Protection and Financial Literacy - Volume I. Key Findings and Recommendations, November 2013, The World Bank

Table II.1.14 Types and Scales of Financial Institutions[15]

Financial Institution	Financial Institution Number	Number of Access Points
Banks	52	609
ATM	45	1094
MFI	170	486
SACCOS	5845	1620

SACCOS carries out joint savings and financing of agribusinesses and small-scale enterprises and was formed as a regional credit union based on the New Cooperative Societies Act passed in 2003 with the aim of making loans to members based on the reserves held of member savings. To become a member, an individual must hold an amount of stock designated by SACCOS, and must have savings. SACCOS sets an upper limit on the financing amount according to the amount of member savings. Banks that do not actively provide direct financing to farmers also loan to SACCOS, and this can be thought of as a supply mechanism for the indirect provision of financial services to farmers.

We describe the case example below of Madibira SACCOS (commonly known as MSACCOS), the most successful entity of SACCOS in Tanzania. MSACCOS was set up in 2000 in Mbeya Region where the rice cultivation have been grown well, and has grown from the original 19 members to 2,067 members as of October 2014 (966 women, 1648 men) with 3 billion Tsh. Almost all members are engaged in rice production through the Madibira Irrigation Scheme, and receive financing from MSACCOS for seed and fertilizer costs as well as purchasing agricultural machineries. Since there are little savings for the number of members, MSACCOS receives annual financing from a CRDB Micro-Finance Bank for members who apply for financing at the start of the growing season. They use a credit guarantee system through the government, and were successful in negotiating down the previous interest rate of 15% to 11%.

MSACCOS also provides, as is shown in Table II.1.15, business loans to retailers among other businesses, and educational loans for individuals who wish to continue their studies at university. Additionally, to increase the number of female members, they also provide small-scale loans for working capital to sell fried dough[16] and other snacks. When members fall behind on their loan repayments, they have also devised an emergency loan system that can be used temporarily and this has increased the loan repayment rate.

As Table II.1.15 shows, the longest term loan that MSACCOS provides is the loan to purchase agricultural machineries. MSACCOS began financing machineries in 2011. They received financing from the Tanzania Investment Bank (TIB), and channel this financing to their members who purchase the farm equipment on Table II.1.16.

[15] From the National Financial Inclusion Framework, Tanzania National Council for Financial Inclusion

[16] Fried dough known as *mamdazi* is a snack often eaten in Tanzania

Table II.1.16 List of Purchased Farm Equipment

Agricultural Machinery	Manufacturer	Amount	Price (Tsh)
Tractor	Massay Fergson	6	72,000,000
	Rikyu		25,000,000
Power Tiller	Kubota[17]	16	10,500,000
	Chang Fa	44	5,500,000
	Dong Feng		

Source: list made from interview (16th October 2014)

Previously MSACCOS faced a situation where a farmer was late to repay the loan because his Chinese-made power tiller broke down; MSACCOS negotiated with the TIB, and was able to take measures to continue the repayments, such as recombining loans to extend the repayment period.

The strength of introducing farm equipment is an increase in labor productivity versus limited time and labor resources. On this point, it is reported that there is a trend for farmers to move away from Chinese-made equipment that, while inexpensive, breaks down easily during ploughing times and harvest times, and to move towards purchasing Indian or Japanese-made equipment. Even MSACCOS is less actively financing the purchase of Chinese-made power tillers in light of their break down history. They don't declare which equipment farmers should buy, but they are careful in their financing so as to avoid a situation where a repayment ceases on a loan to purchase machineries.

One of the factors that MSACCOS is the most successful entity of SACCOS is the great management ability of MSACCOS. According to the Private Agricultural Sector Support (PASS), which carries out guarantee work, when financing is provided to agricultural cooperatives, such as SACCOS, the management ability of that organization becomes the collateral for PASS, and serves as the criteria to judge whether or not the financing can be granted. Since MSACCOS educates their members on financial knowledge and provides guidance for loan repayment, the default rate is quite low at between 3 to 5%. Thus, by belonging to an agricultural cooperative with this degree of management ability, financial services can be accessed in a variety of circumstances. Also, since agricultural cooperatives, like SACCOS, can deposit a sizable sum in a commercial bank, the commercial bank will then be able to more easily provide more financing.

The most active in financing farmers is, as what is stated above, the commercial bank CRDB Micro-Finance Bank. According to an interview conducted at the Mbeya Branch of CRDB Micro-Finance Bank, they actively search for villages and regions with the potential for business expansion through improvements to agricultural production and processing, cooperate with the Mbeya regional administrative office to offer assistance in the formation of agricultural cooperatives, to educate people in financial literacy, and financing farmers. However, since the largest risk to financing agriculture is loss of crops due to weather, they are not actively financing in small-precipitation regions without irrigation-scheme agricultural cooperatives. Additionally, since there is little market demand for rough

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17 The price of a Kubota cultivator includes the water pump, trailer, and disk plow.

rice, and the trading price is low, they often make the proposal to agricultural cooperatives to engage in value-added activities, such as rice polishing or packaging.

Apart from CRDB Micro-Finance Bank, TIB and NMB (National Microfinance Bank) also finance agricultural cooperatives, but they do not visit agricultural communities to assist them in forming farmer cooperatives. In terms of provisionally assisting agriculture, TIB is more active in financing processing, rather than agricultural production.

To mitigate risk in financing the agricultural sector, commercial banks sometimes have users use institutional guarantees. The previous example, PASS Trust, is a civil guarantee company that guarantees agricultural financing, and carries out guarantees, business plan creation and acts as a mediator between banks and agricultural cooperatives. PASS began as a project to guarantee agricultural financing, incorporated in 2000 owing to its successes. Up to now, it has guaranteed financing from a minimum of 7 million Tsh to a maximum of 5 billion Tsh, and has allowed every scale of agricultural financing. When financing the purchase of farm equipment, PASS implements guidance to increase the operating rate and creates a business plan with the purchaser. For example, with the purchase of a cultivator, they hash out a business plan where the borrower can repay the loan in 3 to 4 years by achieving an annual operating rate in 8 to 11 months through the recommendation of purchasing at least three attachments at the same time, and not only doing ploughing work, but also attaching a trailer for transporting, and attaching a thresher to thresh the harvested rice. In cases where buying attachments are not appropriate or the purchaser does not wish to do so, they will propose supplying a fee ploughing service to increase the operating rate. To ensure that the purchaser remains cognizant of the amount of the purchasing price and their obligation to pay back the loan, PASS will advise the purchaser to visit the farm equipment dealer to select the machine he will purchase, and to obtain a pro forma invoice. If the machine the purchaser selects is deemed to be of a high risk to break down, they will discuss this risk with the purchaser, but they will not instruct which machine should be purchased so as to avoid any subsequent liability issues.

PASS pays significant attention to setting up a business plan, and this accounts for their low default rate of 5%. Should repayment not be possible and only in unavoidable circumstances, support can be given to readjust the loan.

Additionally, they provide financial assistance to not just agricultural cooperatives but also individual farmers; but in either case, they cannot be eligible for financing if they do not have an irrigation system installed if they are not blessed by the weather in their area. Further, for individual farmers to receive financial assistance, it is conditional that they must possess at least 50 acres (approximately 20 hectares) of land and be experienced in farming. Also, when the individuals are referred to a bank for financing, they are carefully vetted to assess if they meet the conditions of the bank. For example, CRDB Micro-Finance Bank doesn't just finance unions, such as SACCOS, but also finances individual farmers, but TIB only finances through SACCOS.

For a farmer to purchase farm equipment, he can either join a union, like SACCOS, use a credit guarantee company, like PASS, or use both to procure a sizable loan from a bank. To these ends, we believe that financing comparative capital, as well as providing education and training for highlyeducated people from among small farmers is needed to raise financial literacy and to strengthen the management of SACCOS. It is considerable that a realistic method to increase agricultural productivity for the whole region is for those who have already purchased farm equipment to cultivate not only their own land, but also plough other people's lands for a fee so that they can increase their operating rate and repay their loans.

Table Ⅱ.1.15 types of Loan

Type of Loan	Purpose	Amount of Financing (Tsh)		Interest	Payment Period	Collateral
		Minimum	Maximum			
Agricultural Loan	Financing of capital required for agricultural production. Seeds, fertilizer were gradually loaned out as needed previously, but they are loaned out all at once now.	400,000	1,000,000	15%	9 months	Buildings
Agricultural Machinery Loan	Financing of capital required for agricultural mechanization.	55,000,000	72,000,000	20%	4 years	Buildings
Business Loan	Financing of working capital for the running of retail businesses or rice trading operations.	500,000	10,000,000	20%	1 year/2 years[18]	Buildings
Small Business Loan	Loan limited to women. Financing of small businesses, such as the making and sales of fried dough (mamdazi)	20,000[19]		5%	10 weeks	Buildings
Housing Loan	Financing to build housing and shops. (Since a building is used as collateral, individuals who already own buildings take this loan to build new buildings.)	No minimum	10,000,000	20%	1 year/2 years	Buildings
Education Loan	Loan to continue studies at university.	500,000	2,000,000	20%	1 year (by installments)	Buildings
Emergency Loan	This is a loan for when the repayment of another loan falls into arrears. Financing is done according to conditions, such as with illness or injury, to enable repayment of the original loan.	100,000	200,000	5%	3 months	Buildings
Warehouse Loan	This loan uses the Warehouse Receipt System. It is not currently available[20]					

[18] 1 year for amounts 5 million Tsh or lower; 2 years for amounts 5 million Tsh or higher.

[19] When members borrow 20,000 Tsh, they can acquire SACCOS membership by saving part of the repayment amount in SACCOS.

[20] A collateral manager was hired through the direction of the government, but he was dismissed after trouble occurred. The warehouse loan was subsequently ceased.

2. Republic of Uganda

1) Situation of rice milling industry in Uganda and the potential for the participation of Japanese manufacturers

(1) Rice market in Uganda and development of rice industry

Major changes appeared in the rice milling industry in Uganda due to the increase in the number of small scale rice-milling plants that was associated with the rapid rise of upland rice production since 2000 (see Figure II.2.1). According to Kikuchi et al. (2013), there were 645 rice-milling plants in 2012, an increase of 50% or more in the last five years. Within the region, 50% or more of milling plants are concentrated in eastern Uganda; the dramatic increase in the northern and western areas is 240% during the same five-year period. This illustrates the fact that the spread of upland rice production in northern and western Uganda differs from the paddy rice production of aroma rice represented by Supa (multi-variety brand name). Large or mid-scale rice millers were entering into the market in the same period, Tilda Ltd. that targeted export and selling in supermarkets and Upland Rice Miller Co. Ltd. (URMC, see Photo II.2.1) which focused on the general domestic market are typical examples. According to Kikuchi et al. (2013), while the domestic rice markets are polarized between the upper end of the market that trades high price, branded, small packaged rice mainly through supermarkets, and the traditional market that sells small amounts from a large sack. The movement towards market integration is observed as some of the local traditional markets are also selling branded rice. Furthermore, the number of rice-milling plants is declining in the eastern area, where rice cultivation is thriving, due to exposure to competition with the rise of large-scale rice-milling plants that have high quality rice polishing capabilities. This situation suggests that the awareness of high quality rice is increasing in the traditional market; increasing demand for high quality rice to be shipped from the small rice-milling plants is expected in the future.

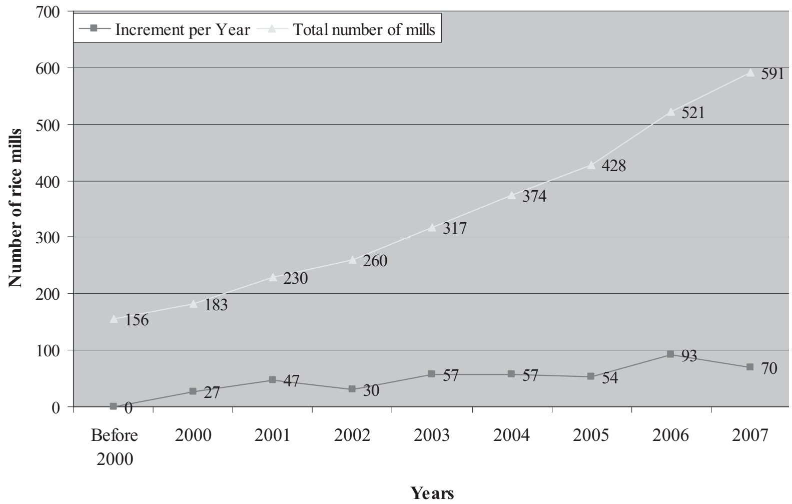

Figure II.2.1 Changes in the number of rice milling plants in Uganda
Source: Candia et al. (2008)

Photo II.2.1URMC rice milling system
(Photography by author)

BOX: Overview of Upland Rice Millers Company Limited (URMC)

Establishment and major facilities

URMC was established with shareholders, Amb. Philip Idro and Mr.Aaron Obulejo, in the industrial area of Jinja in 2006, as a rice milling and drying business. The rice milling system comprises hopper, paddy cleaner, stone separator, paddy husker, paddy separator, rice polisher, rice grader, rice whitener, rice weighing and packing, and all are made in China. In addition, machines for testing performance including moisture meter, testing mill, and rice sieve are installed in the rice milling inspection facility.

Rice milling capacity: 2 tons per hour

Drying capacity: per hour (made in England)

Warehouse space: 3,000 tons

Business overview

General large-scale rice millers purchase paddy from farmers and sell rice after milling, but a series of services with fees offered by URMC include drying, milling and packaging rice rather than just purchasing paddy. Current rice milling and packaging charge is 150 Ush per kg (Uganda Shilling: USD 1 = Ush 2,800). 10,000 rice farmers, located mainly in eastern and northern Uganda, are customers. URMC also offers warehousing free of charge and does not collect a storage fee. Consignment sales are also available depending on the customer's request. The fees are 40 Ush per kg for drying, 35 Ush per kg for rice cleaning.

In order to ensure customers, URMC provided rice cultivation guidance to more than 8000 farmers. Through these activities, farmers had a significant impact, increasing their income by selling rice without a broker, and increasing the average yield from 800 kg to more than 1.5 tons per acre.

URMC has been honored as an excellent private organization in the fifth meeting of the Coalition for African Rice Development (CARD). URMC is recognized as playing a key role as secretariat office in the preparation of organizing the rice millers in Uganda, and is increasingly expected to be the main driver for the project.

(2) Current situation of rice milling industry

This section describes the overview of the rice milling industry based on the findings of interviews from 70 rice-milling plants that were conducted by Kikuchi in 2012 (Kikuchi et al., 2013). 83%, or 58 plants, started their business in 2000 or later. Since 2010, 24%, or 17 plants, started their business, 11 of them are located in the eastern area. Occupation prior to becoming a rice miller was agriculture-related work, accounting for about 60% mainly maize flour millers, and quite a few farmers started rice milling. A wide range of prior occupations is observed, such as doctors and public officials. These data indicate that the entry barrier to the rice milling industry is low because the burden of initial investments is small and the technical requirements for quality rice milling is also very low.

The average number of machines owned by rice-milling plants is 1.4 units, approximately 90% of machines were purchased in 2000 or later, and the machines are replaced every 5 to 8 years. Major models used by a small rice-milling plant are made in China mill-top (see Photo II.2.2) SB-10, SB-30, and SB-50 that are imitations of SATAKE machines, and an improved Engelberg with a blower N-70 and N- 120 that are also made in China (see Photo II.2.3). Mill-top type is often used in the emerging upland rice cropping areas in northern or western Uganda.

Photo II.2.2 Rice miller (right) and N−70 in the Mayuge disctict (Photo: author)

Photo II.2.3 Rice miller and SB−10 in the Amuria district (Photo: Natsuko Miyamoto)

Regression analysis (risk factor: 5%) shows that the mill-top type had surpassed the Engelberg type in milling capacity per hour (Kikuchi et al., 2013). The average rice yield based on the survey is 65% and no significant regional difference is observed. As shown in Figure II.2.2, the mode is 65 to 69%, 10% or more of respondents are at 70 to 74%, and three plants responded with 40 to 49%. Higher yield rate indicates that millers ensure the volume of rice even with a low whiteness, lower yield rate indicates that the rice was brought from a farmer where winnowing has not been done sufficiently, or the broken rice rate is too high. Average floor area of facility is 33 m2 for the space of milling machines, 42 m2 for a warehouse and many of the buildings are old. In terms of the cost, fixed costs of the mill-top type and improved Engelberg are 25% and 33% respectively. Most costs were for

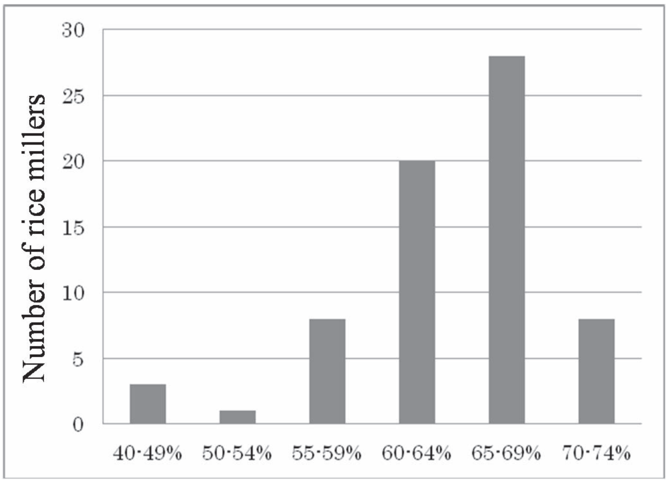

Figure II.2.2 Number of rice milling plants by yield rate (parameter: 68), Source: Kikuchi et al. (2013)

buildings rather rice milling machines. It seems that the barriers to entry into the rice milling industry are very low due to the small initial investment without spending on facilities.

The average annual amount of rice milled by small rice-millers is 350 tons. Rice-millers that mill more than 700 tons per year own more than one rice milling machine or the mill-top type. The average amount of rice milled in emerging regions is small, but a relatively larger amount was processed in the northern area. 80% or more of the milled amount is processed during the harvest period in the rainy season or the second rainy season. Regarding the paddy procurement, farmers directly bring 70%, pick up by collector is about 20%, and about 10% of paddy is purchased by rice-millers. According to Kikuchi et al. (2013), the average collection cost is 4,000 Uhs per 100 kg bag, and the estimate of average range is an area within a 70 km radius. In the western area, approximately 60% of rice millers are full-time, but many millers in other areas double as distributors.

A typical staffing example is one manager, two operators and two assistants for the milling machine, and four other employees for receiving, drying, and cargo handling. Generally, the manager is a permanent employee (salary), operators are permanent or temporary employee (salary or daily wages), and other employees are temporary hires. Electricity is used for 70% of power, and the rest of power is diesel. Most of the rice millers would like electrical power in terms of maintenance and cost. However, power outages occur often and have a great impact on business. The average annual repair and maintenance expense for a milling machine is approximately 60,000 Ush for mill-top mill and approximately 90,000 Ush for an improved Engelberg machine. Repair frequency of mill-top machine is less than the improved Engelberg machine, no statistically significant difference was found between two machines due to the large variation in the frequency of failure. The cause of the variation is that the strong relationship between repair cost and the annual amount of milled rice or age of machine rather than the type of machine. A strong correlation is observed between the logarithm of the repair cost and the amount of rice milled.

Rice milling fee per kg is 150 Ush in the northern area, 120 Ush in the eastern area, 141 Ush in the western area, and 178 Ush in the central area. Seventy Ush as the rice milling fee is observed in the eastern area, which has a long history of rice cultivation, due to the intense competition and the large amount of milled rice. Some farmers take the by-product, rice bran, and there is no rice-miller selling rice husks. As a result of having calculated the break-even point at 100 Ush per kg, approximately 100 tons per year is needed for the improved Engelberg type with 20 horsepower. However, if the calculation is based on 70 Ush per kg, at least 600 tons of per year is required for profit. (Tokida et al., 2014)

(3) Rice quality in Uganda

The rice quality standards in Uganda were defined by the Uganda National Bureau of Standards (UNBS) in 2005, and the standards are also used in the East African Community as common criteria. The standards are prescribed in terms of physical properties such as the percentage of broken rice or proportion of impurities, and chemical properties such as the presence of aflatoxins for food safety. Nevertheless, these criteria are not applied to most of the rice distributed in Uganda. There are two main reasons for this. One is the market demand for quality rice was low and the other is the amount of rice which needs to meet the criteria was small due to the non-branded rice distribution from small rice millers to traditional markets.

The situation of rice quality in Uganda is described below. Table II.2.1 shows the inspection results of 27 rice samples performed by the author in the period from July 2014 to January 2015. The inspection was performed on samples collected from all over the country, and no significant difference of rice quality between regions, measured by the percentage of broken rice, was observed. In addition, three samples from mid-sized rice millers were not classified as grade 1. It seems that the quality is greatly affected by differences of milling machines and operator skill in the rice millers, as well as the condition of the paddy brought by farmers. In other words, the rice that is distributed in Uganda has

Table II.2.1 Regional rice quality

Region	Rice milling machine	Variety	Moisture content %	Percentage of broken rice (%)	Damaged grains (%)	Number of stones
C	SB	Kaiso	13.1	32.9	7.7	1.7
C	SB	Kaiso	15.3	16.2	4.0	1.3
C	SB	Kaiso	15.3	27.6	3.5	0.0
C	SB	N4	12.3	53.3	14.7	5.3
C	SB	N4	14.0	44.5	7.8	0.3
E	N	Kaiso	9.8	59.7	5.0	5.3
E	N	Kaiso	12.3	49.7	6.0	0.3
E	N	Supa	9.8	20.8	3.0	0.0
E	N	Kaiso	10.0	62.3	8.3	0.0
E	N	Kaiso	14.2	43.4	5.8	1.0
E	N	Kaiso	11.9	53.8	14.0	17.3
E	N	Kaiso	13.3	52.4	2.8	6.7
E	N	Kaiso	11.1	41.9	38.5	3.3
E	N	Supa	10.1	32.5	6.5	1.0
W	SB	Upland	11.7	43.2	6.5	1.0
W	SB	Upland	15.4	26.5	6.2	0.0
W	SB	Upland	14.2	36.6	5.6	0.3
W	SB	N4	13.8	45.6	7.9	1.7
W	SB	Upland	13.3	49.3	8.3	10.0
W	SB	Sparia 2	11.4	50.3	7.3	3.0
N	N	Supa	11.9	30.2	5.8	6.0
N	SB	Sindano	11.9	41.0	7.3	0.0
N	SB	Sindano	10.3	33.3	8.6	2.0
N	N	Supa	10.2	38.6	4.6	0.0
E	M	Upland	12.1	24.0	14.1	0.0
E	M	Upland	10.5	21.6	18.9	0.0
E	M	Upland	11.3	36.1	13.4	0.3

Region: C is Central, E is Eastern, W is Western, and N is Northern

Rice milling: SB is mill-top mill, N is improved Engelberg mii, M is a medium-sized system

Percentage of broken rice: Grade 1 is 10% or less, grade 2 is 25% or less. grade 3 is 50% or less

Damaged grains: Grade 1 is 1% or less, grade 2 is 2% or less. grade 3 is 4% or less potential to improve quality by implementing a high-quality rice milling system and has a requirement for the technical improvement of farmers who are in the production phase.

Most rice has good condition with 15% or less moisture content, but some rice contains less than 10%. This will make a few percent weight loss for the farmers. According to the survey result, six samples were found to have more than 50% of broken rice. The main reasons are considered to be due to the drying process and the harvest period. This sort of rice having a high broken percentage cannot satisfy the grade, and the price is close to that of 100% broken rice even though it is salable. Most of damaged grains are chalky caused by insect pests or heat. Many samples are having more than 4% of damaged grains and not all of them satisfy the grade. In order to make better quality rice, farmers' rice cultivation and post-harvest handling technologies must be improved. The criteria for impurities are defined according to their percentage in the total weight: 0.1% or less for grade 1, 0.3% or less for grade 2, and 0.7% or less for grade 3. Stone, which is an impurity, is not defined as a specific impurity in the standards. That means when the total weight of impurities is less than the criteria, the rice can be classified as the grade 1 even if it is containing stones. However, the evaluation of rice with stone in the market becomes extremely low and it loses customers. One of the reasons customers prefer imported rice is that it contains no stones. Almost 100% of stones can be removed from rice by installing a de-stoner. The issues that have a big impact on the market should be addressed regardless of whether it is not prescribed in the standard.

(4) Future direction of the rice milling industry

In recent years, the amount of rice imported in Uganda has remained between 50,000 and 60,000 tons. Most is imported from Asian countries such as Pakistan or Vietnam, and its quality is consistent without stone contamination. On the other hand, it is estimated that about 150,000 tons of domestic white rice has been produced. Much has been processed by small rice-millers, but paddy, red rice, and stone are mixed, and the percentage of broken rice is higher. As described above, demand for higher quality is also growing in the general market, not only at the upper end of the market. Considering the market demand in Uganda and neighboring countries, improvement of quality will be essential. In other words, if the current quality standard is maintained, it is expected that the Uganda rice may lose its market. However, many of the rice millers in Uganda are aware of the domestic competition, only some of the largest rice millers sense competition from imported rice.

Promotion of Rice Development (PRiDe) Project of Japan International Cooperation Agency (JICA) has been providing support for studies of rice in the research institutes, mainly in the National Crops Resources Research Institute (NaCRRI) where the most project activities were implemented, dissemination of the rice cultivation technology for farmers, and support in the improvement of rice quality to rice millers. Prior to the start of PRiDe Project, JICA provided the technical training for rice mill operators to improve their skills, and this has resulted in raising most of the operators' rice milling capabilities above grade 3 of broken rice percentage. Providing training to rice mill operators, estimated at 1,000 people or more in over 600 small rice millers across the country, is not easy. However, the improvement of the operations in rice-millers, as well as the farmer' post-harvest handling techniques, in particular, timely harvesting and proper drying technology, is required to upgrade the rice quality. Thus, JICA conducted training of farmers in post-harvest handling techniques and in rice quality improvement for owners and managers of rice millers. This training attempts to raise the rice millers' awareness of the quality of rice and to provide technical guidance to farmers wanting rice milling. With this training, encourage the rice millers, who are dealing with market and farmers to pursue the quality of rice in their role as mediator. Nevertheless, there is no guarantee that the quality of domestically produced rice is always improved even if the skills of the rice millers who participated in the training have improved. Eventually, JICA launched two major activities expecting that the whole industry can try to improve the quality of rice. One was conducting capacity building training for cooperative of small-scale rice millers in rural areas, or sub-committees of small-sized plant organizations. The other activity was holding lectures in collaboration with the Ministry of Agriculture, Animal Industry and Fisheries targeting the medium-to-large scale rice-millers. In these lectures, JICA described the situation of the rice milling industry in Uganda, explained the need for initiatives to improve the quality of rice, and interviewed the rice millers' about their intentions for structuring the rice milling organizations. In the second lecture, the concrete way of organizing was explained by participating rice millers and the formation has progressed to elect officers for a preparation committee. The policy of the organization will be discussed at the next meeting. It is expected that further development of this movement would function as a nationwide organization including representatives of small-scale rice millers.

(5) Potential for the participation of Japanese manufacturers

Rice milling machines, as well as de-stoner and graders (rotary shifter), have been sold in Kampala, and most of them are made in China. Most tillers are also made in China apart from some power tillers that were made in India equipped with diesel engines from Japanese manufacturers (overseas production). Among them, it can be said that the tractor is exceptional because many of them have been imported from a leading international Turkish manufacturer, as well as Brazil and India. Japanese agricultural machinery is imported by the Official Development Assistance (ODA) or personal import, and genuine commercial imports have not started while most of the imported used cars were manufactured in Japan and have a good reputation for high quality. In order to boost the agricultural machinery market, Japanese agricultural machinery manufacturers should enhance the spare parts supply system, enrich after-sales services including repair and maintenance, as well as offer a sales price which can compete with the current product price in the market . Since 2014, Japanese agricultural machinery manufacturers have had a positive impact as the international competitiveness of Japanese products has been increased by the weakening Japanese yen through monetary easing, and the Japanese government announced support in the African market for the private sector through the fifth Tokyo International Conference on African Development (TICAD V).

In 2015, two people, including an executive, from HOSOKAWA WORKS Co., Ltd. participated in the third agricultural mechanization survey team, organized by the Japan Association for International Collaboration of Agriculture and Forestry (JAICAF), and investigated the potential of agribusiness in Uganda. The aims of the investigation are an adaptability examination of rice milling machines for rice varieties distributed in Uganda, demonstration of de-stoner in the rice milling training, and studies of the current situation of local post-harvest and agricultural mechanization. The Rice Promotion Project supported this investigation actively.

In the local feasibility examination, it was verified that the percentage of broken rice could be lowered by improving the shape of screw shaft for rice-polishing. However, the wear of the rice-polishing shaft for specific varieties was remarkable. Further improvement including the material will be required for the high frequency of use. In the demonstration of the de-stoner, functions of the product were explained, and after adding stones and rice in the de-stoner, it was confirmed that all stones were removed. The participants were satisfied with its performance, and asked questions about the hourly milling amount and sales price. In addition, some de-stoner models were requested such as with the processing capability corresponding to the rice-milling machine (SB-10) that currently they own, and driven by an engine, as there is no electrical power supply.

In response to the requests, processing capacity issues would not occur if a rice shop uses a de-stoner equivalent to that used in demonstrations. Changing the specification of the motor to single phase 240 V is possible, the operating ratio can be raised if multiple shops use a shared de-stoner. However, the rice shops do not have enough funds to purchase a de-stoner, are concerned as to whether they lose their current income by de-stoning or impurities manually, and have yet to consider purchasing a de-stoner. The manual sorting work charges 4,000 Ush per rice 1 bag (100 Kg), the funds for the machine can be recovered if it could process about 700 bags. No rice shops have introduced the de-stoner, but if some of them start using the machine, the awareness of the quality of rice will grow rapidly and could be popular at the same time.

(6) Sales and local production potential of de-stoner

It is clear that the needs of the de-stoner by the market and rice miller are high, and the gravity method is appropriate from this JAICAF survey. However, improvement in terms of processing capacity and cost reduction are the immediate issues. Currently, the capacity of a rice milling machine that is popular in small rice-millers is 800 kg per hour or more while the capacity of the de-stoner in the demonstration was 300 to 400 kg of brown rice per hour. Therefore, the processing capacity must be more than doubled to meet demands from rice millers. In this case, it may take long time to improve the capabilities because screen part design and overall design must be reviewed. The processing capacity of the de-stoner sold in Kampala that is made in China is 2 tons per hour and the price is approximately 670,000 Yen. On the other hand, the cost of the demonstration machine is 87,000 yen free on board (FOB), so export, transportation, and customs procedures costs will be added. In an effort to reduce costs, an assembly method was examined where only the important components are exported to be assembled with locally manufactured parts, rather than exporting the finished product. The survey team brought the de-stoner for demonstration into the agricultural machinery manufacturer, Tonnet Agro Engineering Co., Ltd., in Kampala and conducted the verification of local production parts. As a result, the de-stoner will be designed based on the condition that the screen, swinging part, and blower will be supplied by HOSOKAWA, and the frame, hopper, and driving device will be manufactured locally. The sales price will be considerably reduced. If the original processing capacity could be built as more than 1 ton per hour, the stone separator capacity can be improved by attaching a large hopper having a buffer function. Accordingly, a large market potential is expected by this functionality at a price equivalent to the Made-in-China stone separator.

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JAICAF

REPORT ON

FEASIBILITY SURVEY ON SUITABILITY OF MECHANIZATION WITH SMALL AGRICULTURAL MACHINERY FOR SMALL SCALE RICE FARMERS IN TANZANIA.

By

Pius Galinoma Mihayo

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

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Table of contents

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ABREVIATIONS AND ACRONYMS

JAICAF	Japan Association for International Collaboration of Agriculture and Forestry
KATC	Kilimnjaro Agricultural Training centre
LMIP	Lower Moshi Irrigation Project

EXECUTIVE SUMMARY

The government of Japan through JAICAF conducted a feasibility survey on mechanization in Tanzania.

This project was meant to encourage private sector's agribusiness investment and to contribute to income generation and poverty reduction of smallholders farmers through conducting a feasibility survey on agricultural mechanization to increase agricultural production and to improve agricultural productivity in sub-Saharan Africa. Tanzania was selected as a main project target country which focused on paddy field rice farmers to implement practical feasibility survey and general socioeconomic survey.

In this project, a feasibility survey was carried out on agricultural machinery around Lower Moshi irrigation scheme area at KATC paddy fields. In this survey, machineries were introduced to every process of rice production until the stage of consumers. In addition to the survey, relevant information on mechanization was gathered and basic training was done to operators to optimize operation efficiency.

Team of expert was dispatched four times to be present at each process of rice production during the entire period of the survey. Along with the main feasibility survey, fact finding was carried out.

The purpose of the survey was to encourage private sector's agribusiness investment and to contribute to income generation and poverty reduction of smallholders through conducting a feasibility survey on agricultural mechanization to increase agricultural production and to improve agricultural productivity in sub-Saharan Africa.

The site for the survey was at Kilimanjaro Agricultural Training center which is located In Chekereni Village, Mabogini ward Moshi Rural district Kilimanjaro region in Tanzania.

1.0 INTRODUCTION:-

1.1 Background and rationale of survey.

Several years ago there was relatively little concern for meeting projected food demand through improvements in crop productivity, today there is increasing awareness that “business as usual” will not allow food production to keep pace with demand, a situation that may result in dramatic rises in food prices, poverty, and hunger. Indeed, until recently, the most widely used computational equilibrium models that evaluate global food supply and demand predicted that, grain prices would remain constant or decrease in coming decades.

Three things are responsible for this remarkable turnaround in prognosis for global food security: (1) Economic development rates in the world’s most populous countries have consistently exceeded projections by a wide margin; (2) large increases in demand for energy, grain, and livestock products in these countries due to a rapid rise in purchasing power; and (3) global slowing of crop yield rates of grain. It is now clear that during the next several decades, as human population rises towards a climax at 9 + billion every hectare of existing crop land will need to produce yields that are substantially greater than current yield levels. However, some regions have much greater potential than others to support higher yields in a sustainable manner, due to their favourable climate, soil quality, and in some cases, access to irrigation. In some of these favourable regions current average farm yields are low especially in Africa. Hence, a large exploitable gap exists between current yields and what is theoretically achievable under ideal management.

Rice (*Oriza sativa*) is the major food crop of nearly half of the world’s population. The total rice-cropped area and rice production in the world were 147.14 million hectares and 576.28 million tons, respectively.

In view of the above, to address one of the limiting factors in crop production is the introduction of appropriate small scale machinery, which will provide alternative source of power in crop production, as the existing one use of hand hoe has limitations in optimizing crop productivity.

Japan Association for International Collaboration of Agriculture and Forestry (JAICAF) is conducting feasibility survey test on suitability and efficiency of mechanization with small type agricultural machinery such as hand tractor and associated implements including post-harvest equipment for smallholder farmers in Tanzania.

Feasibility Test of Agricultural Machinery Introduction to Rice Farmers in Lower Moshi Irrigated Paddy. For this test, it was planned to carry out mechanization feasibility experiment mainly on Power Tiller. Taking cultivation structure, conditions of agricultural machinery and tools, and field conditions into consideration, where comparison was done on manual labour and machinery operation to see the improvement effect on rice productivity.

Assessment of the power tillers and its attachment was done by Mechanization Expert Inami followed by Matsumoto who both confirmed the use of the machinery at KATC to meet the desired goals of the survey.

1.2 Purpose of the Feasibility Survey.

To encourage private sector's agribusiness investment, to contribute to income generation and poverty reduction of small scale rice farmers.

1.3 Specific objectives

i) Compare the time, fuel consumption, and human labour input of the power tiller-plough, Rotor and hand-hoe plots.

ii) Observe the difference in amount of work necessary for weeding caused by difference in paddling and levelling.

iii) Compare amount of weeds for each treatment.

iv) Compare time and cost involved in harvesting and post-harvest activities.

v) Compare time involved in winnowing/ cleaning

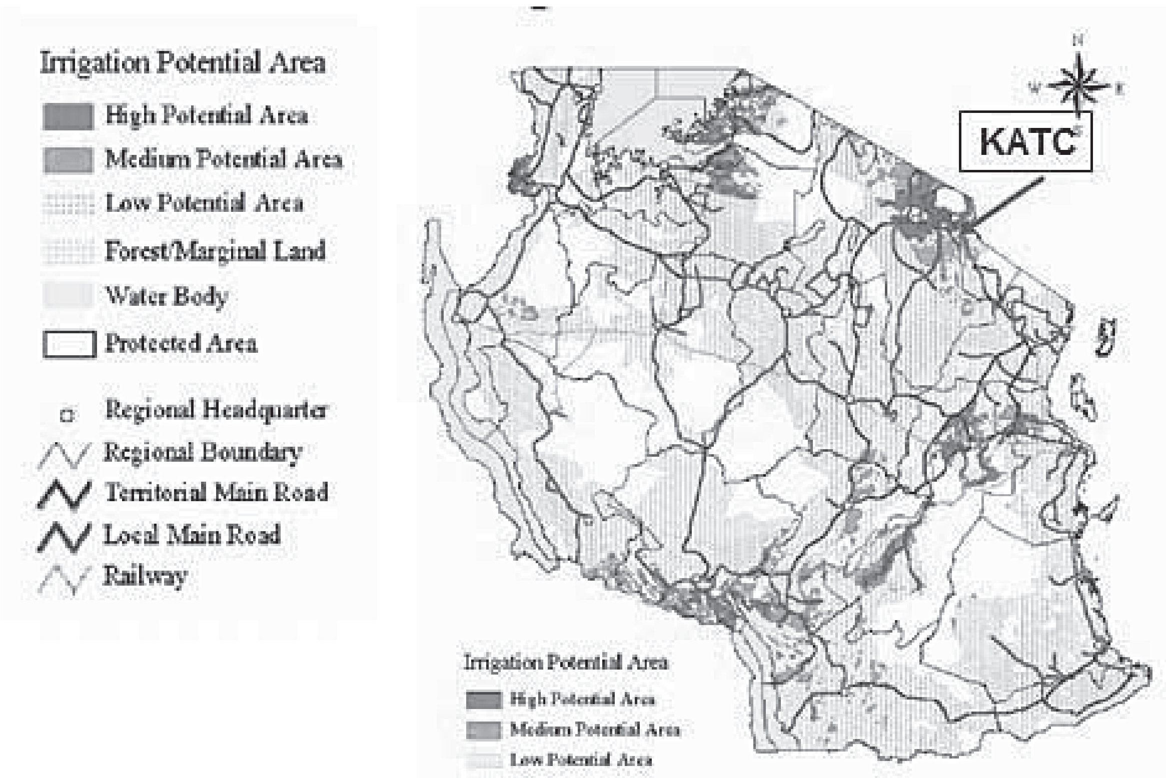
vi) Compare grain recovery ratio for rice milled on locally available milling machines.

1.4 Location and description of the survey site.

The experimental field was located at the Kilimanjaro Agricultural Training Centre (KATC) farm in the Lower Moshi Irrigation Project (LMIP), 17 km in Moshi rural district, Kilimanjaro region which is south-east of Moshi town.

Moshi Rural district.

Moshi rural district is located in northern part of Tanzania, where the neighbouring areas are on the northern side is Kenya Taveta, Estern side is Rombo district, western side is Hai district and southern side is Mwanga district.

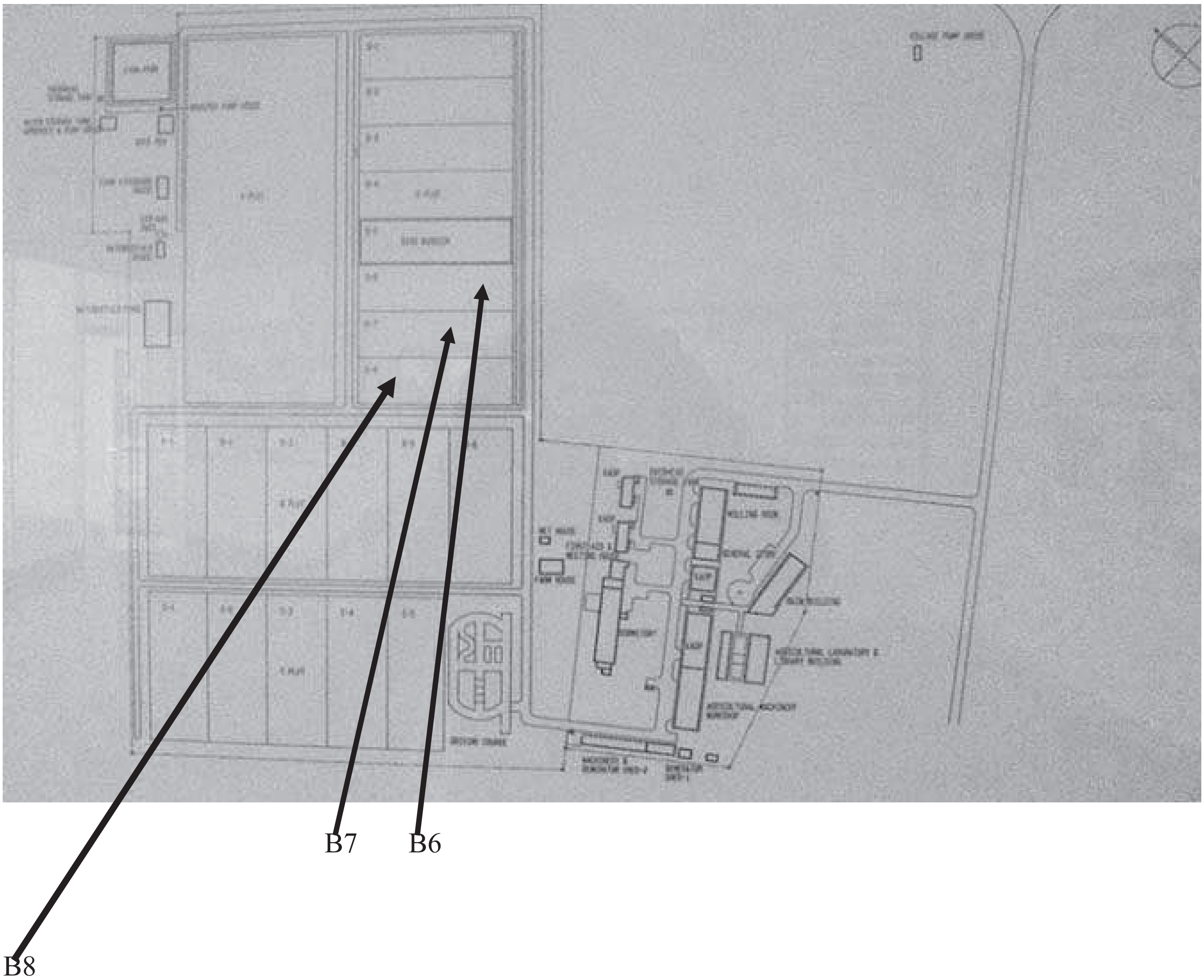


MAP OF TANZANIA INDICATING KATC SITE LOCATION

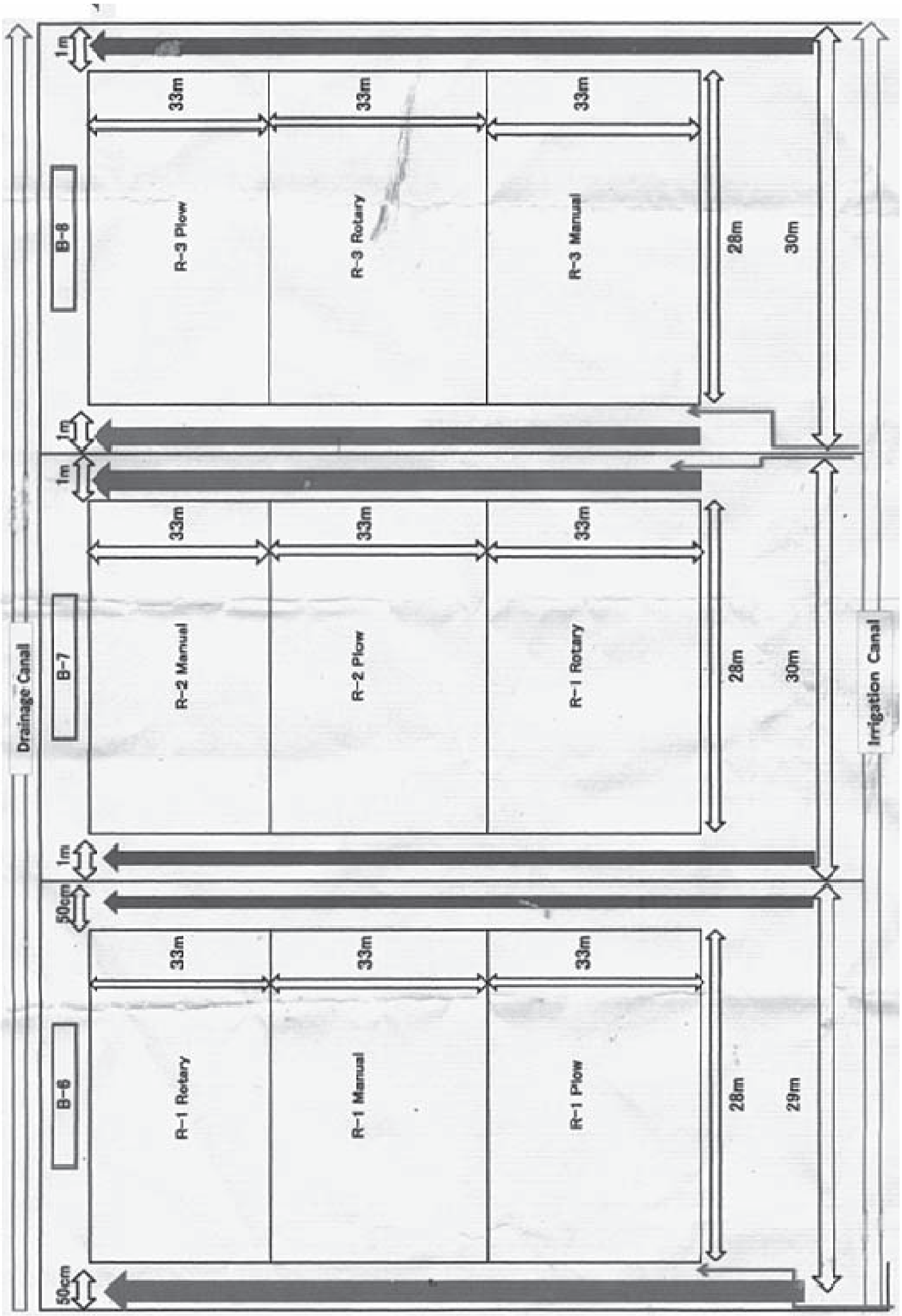
2. METHODOLOGY

2.1 A total of 0.9 ha of rice were grown at KATC rice fields in Chekereni village Moshi rural district. Comparison tests between human power and small scale machinery (power tiller) were done covering rice production system from land preparation (ploughing, paddling and levelling), planting, weeding, harvesting, threshing, winnowing and milling (grain recovery percentage). There were three treatments Manual, plough and rotor which were replicated three times hence there were nine plots in total having three plots for each treatment The replication were B6, B7 and B8. All the rice plots were given similar treatments.

Map of KATC compound:-



Field layout:-



2.2 Rice seed and nursery preparation

2.2.1 Seed preparation

The method used to select seed was that of using salt water where, a salt solution was prepared which was around 1.13. The specific gravity is approximately 1.10 when end of the egg surface just breaks the solution surface. The specific gravity is approximately 1.13 when the surface area of the egg is above the solution surface reaches a diameter of 20mm. The amount of salt used was 2kg in 10 litres of water in order to obtain fully developed endosperm seeds. This salt solution made the seeds with endosperms not fully developed to float Refer diagram below

.

Figure Bucket of water mixed with salt indicating floating Egg and paddy kernel

The procedure for selecting seeds with fully developed endosperm is as indicted, ten litres of water and 2 kg salt were prepared, Salt was mixed to ten litres of water in a small bucket, addition of salt was done gradually, while starring water and placing in the egg to see if the egg starts to float water. The procedure above continued until the right specific gravity was attained. The egg was removed and the seeds were put into the container while staring. The floating seeds were removed; water mixed with salt was poured out, the seeds which did not float was thoroughly washed with fresh water five times.

2.2.2 Preparation of wet seedbed

The land was prepared 3 days before sowing, where seedbed were constructed with the size of 1.5m wide by 10 m, mud was collected around the predetermined area and was raised about 4-5 cm above original soil level in between the nursery beds path were constructed, from one seedbed to another was 50cm.The surface was levelled to allow uniform distribution of water.

2.2.3 Rice seed sowing

The pre-germinated seed were broadcasted on the nursery at the density of 100 grams per m^2; finally the broadcasted seed were covered with soil well by tapping with hands. The tapping was done slightly to avoid deeper sowing of the seeds. Float, was the washed with fresh water five times, to avoid damage of the seeds.

The number of seedbed were nine in total where for each replication three nursery beds were required to have adequate seedlings for transplanting as well as gap filling.

2.2.4 Nursery management

After sowing the management involved was Irrigation of the seedbeds with just adequate amount of water on the first week. The water was applied to cover the seedbeds(refer picture).

2.3 Land preparation

2.3.1 Comparison test between Manual (hand hoe), rotor by power tiller and plough by power tiller for ploughing operation

The first basic operation for land preparation of rice field was that of ploughing, three methods were used, hand hoe, power tiller plough, and rotor by power tiller, the parameters involved under this activity was comparison of time used to finish the activity and as power tillers amount of fuel used was also measured. The tools which were used for ploughing operation were power tiller plough, power tiller rotor, and hand hoe for manual operation

2.3.2 Comparison test between Manual (hand hoe), rotor by power tiller and harrow by power tiller paddling operation

After first operation of ploughing the plots were left for several days and during this time water was supplied to provide adequate moisture to organic matter incorporated into the soil the resting time was important to provide ample time for inorganic matter to decomposed, before transplanting the rice seedlings.

The attachment used for paddling operation were, power tiller rotor on rotor treatment, power tiller harrow on plough treatment, and hand hoe on manual treatment as indicated in the picture below

Figure 1 Paddling by power tiller rotor

Figure 2 Paddling by power tiller harrow

Figure 3 Paddling by hand hoe

2.3.3 Comparison test between Manual (hand hoe) levelling by power tiller operation

The next operation of land preparation after paddling was levelling this operation involved use of power tiller leveller, for both treatments of rotor and plough. For manual treatment a hand hoe was used as indicated in the pictures below.

Figure 4 Levelling on plough treatment

Figure 5 Levelling on rotor treatment

Figure 6 Levelling by hand hoe on manual treatment

2.3 Transplanting

After land preparation which was finally done by levelling all the plots using methods indicated, the plots were left for three days before transplanting, the first operation was seedling plucking from the prepared nursery plots which was done 21 days after transplanting and the activity took about two and a half hours to obtain adequate seedling to transplant a single replication of 0.3 ha. The activity of seedling plucking is as indicated in the picture.

Figure 7 Seedling plucking from the prepared nursery beds

After seedlings plucking the plots were transplanted, at a spacing of 10cm x 30cm, and the rice variety which was used was SARO 5.refer picture. Due to limited skilled laborer for transplanting skill five laborers were used to transplant a single replication in a day, which took them duration of 7 hours a day on average.

Figure 8 Rice transplanting

2.4 Weeding

Weeding operation was done three times, the first weeding was two weeks after transplanting. The method used to weed was, manual, for plots which were manually prepared and hand weeding tool for plots which were prepared by power tiller (rotor treatment and plough treatment). As indicated in the pictures.

Figure 9 First hand weeding on manual treatment plot

Figure 10 First weeding on power tiller prepared plots

Figure 11 Second weeding on manual prepared plots

Figure 12 Third weeding by rotary weeding tool on power tiller prepared plots

2.4.2 Comparison of amount of weeds for each treatment.

Weeds were collected on each plot, the sample area was one metre square and a total of three sites were used to collect a sample for each plot. During collection of weeds a square meter was with pegs marked with pegs as indicated.

Figure 13 Site marked with pegs ready for weed collection

Figure 14 Collection of weed sample just before first weeding

Figure 15 Collection of weed sample just before second weeding

Figure 16 Weed sample collection just before third weeding

All weed samples were collected in onion bags,

Collected weed samples from one replication.

The collected sample were thoroughly washed to remove all soils on the roots. They were all dried, and weighed to obtain dry weight,

Figure 16 Weighing of weed sample

2.4.3 Pest and disease control:

The crop was sprayed with pesticide and fungicide to protect the crop from the effect of crop damaging agents such as pests, vectors and disease causing organisms the crop was sprayed three times. As indicated

Figure 17 First spraying (two weeks after transplanting)

Figure 18 Third spraying

2.4.4 Water test.

All plots for each replication was tested on amount of water loss and consumptive use, each plot was placed with a marked wooden pole. Four poles were placed on each plot at random position, to obtain four readings for each plot of which the average was calculated and was recorded as a representative data for the plot. Ten days were recorded in one month at an interval of three days.

2.5 Harvesting and post-harvest operations

2.5.1 Harvesting operation

The harvesting operation was done by cutting rice plants, and threshing.

Plots which were prepared by power tiller (rotor and plough treatment) were cut using the ripper machine the ripper used was of four row size and as for the manual treatment were cut using sickles manually the pictures below refers:

Figure 19 Cutting rice by sickle on manual treatment plot

Figure 20 The cut rice by sickle was finally gathered ready for threshing manually

Figure 21 Manual rice threshing

Figure 22 Cutting rice by ripper

Finally after cutting operation the rice crop was threshed on manual treatment it was manually threshed from the arranged rice heaps and for power tiller treatment (plough and rotor were threshed using a Kubota thresher which did both operation of threshing as well as winnowing as indicated in the pictures:

Figure 22 Threshing rice by rice thresher
(two people required collecting crop and feeding the machine)

3. Results and discussion

3.1 land preparation

3.1.1 Ploughing

Comparison test for time required to accomplish ploughing operation for different treatments (manual, rotor and plough the results indicated that with manual operation, although ten people were doing the operation time spent to finish the operation was more than that of rotor and plough. For plough and rotor treatment there was also difference in time in some plots probably this could have been because of the difference in working width of the machines also for rotor there could be less slipping percentage due to the added traction by the rotor attachment. There is a need determine slipping percentage difference in future, to be able to find what made the difference in time for the two treatments. As for cost the treatment for manual is more expensive compared to rotor as well as plough because the cost for the plot for manual plot was 70,000/= T. Shillings. Whereas the cost for plough as well as rotor treatment is less than half the cost. Taking into consideration that the cost for rotor as well as plough treatment includes, depreciation cost, fuel cost and operator cost which in total is less than half the cost of manual treatment.

The results for time spent to finish the ploughing operation as well as fuel used is as indicated in the tables:

Time used to accomplish operation

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	1 hour 30 minutes	1hour 40 minutes	1 hour
Rotor	1 hour 10 minutes	1hour 30 minutes	1 hour
Manual	3 hours 20 minutes	3hours 40minutes	3hours 10 minutes

Amount of fuel used

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	2 litre 70 mls	2 litre 300 mls	2 litres
Rotor	1 litre 900 mls	1 litre 800mls	1 litre 900 mls
Manual	N/A		

3.1.2 Paddling

For paddling operation we had similar situation that paddling manually took a longer period almost three times to finish as compared to rotor and plough treatment. We had difference of time to finish the operation for plots which were prepared by power tiller, rotor and plough treatments the plough treatment for paddling operation took less time than rotor the reason for this is probably due to difference in working width of the rotor attachment as compared to harrow attachment, the harrow attachment has a wider size which was almost three times wider compared to rotor this could have been the reason why this machine working with the harrow spent less time than that of a rotor. Still the time spent finish did not correspond to the difference in working width, this could have been because of the difference in traction resistance, because the power tiller with rotor attachment had an advantage of being propelled by rotor attachment whereas that with harrow was meeting a resistance of pulling the harrow, this could be further suspected so because amount of fuel spent by power tiller operating harrow used more fuel than that of rotor treatment. Probably this could have been the reason of not giving much difference in finishing time. For cost of operation it is similar with the ploughing operation that manually operated plough is expensive as compared paddling using rotor or harrow.

The results paddling operation are as indicated in the tables:-

Time used to accomplish operation

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	50 minutes	44 minutes	1hour
Rotor	1 hour 5 minutes	49 minutes	55 minutes
Manual	3hours 15 minutes	3 hours 23 minutes	3hours 49 minutes

Amount of fuel used

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	1 litre 150 mili-litre	1 litre	2litres 350mili-litres
Rotor	1 litre 800 mili-litre	1 litre	1 litre 750 mili-litres
Manual	N/A		

3.1.3 Levelling:-

Levelling operation had almost similar results like ploughing and paddling, which manually operated plots, took more time to finish the operation but the time spent by manual operation decreased significantly to become almost less than twice, to that of power tiller operated plots but still manually operated plots took longer to finish the operation. There was also difference between plough treatment and rotor treatment. Rotor treatment spent less time to finish the operation as compared to plough. Probably there was a much smooth finish after paddling by rotor treatment than harrow treatment which minimized pulling resistance of a leveller as both treatments used same type of leveller. For cost of operation it is similar with the ploughing operation that manually operated plough is expensive as compared paddling using rotor or harrow.

Time require to accomplish operation

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	50 minutes	1hour	1 hour 40 minutes
Rotor	45 minutes	1hour 10 minutes	1 hour 15 minutes
Manual	1 hour 10 minutes	1 hour 30 minutes	1hour 40 minutes

2.4.2 (Amount of fuel used to accomplish the activity)

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	1 litre 200 mls	1 litre 600mls	1litre 630 mls
Rotor	1 litre 140mls	1 litre 400 mls	2 litres
Manual	N/A		

3.2.1 Weeding

Weeding was done to minimize completion of nutrient from the soil, the labour involved in accomplishing the work showed that it was more laborious to weed manually by hand. Weeding using rotary weeding tool proved to be less laborious. There was a limitation of using this weeding tool as in between the rows require supplementing weeding manually by hand weeding which contributed to increasing in working time, supplementary weeding was more tedious in second and third weeding. Hence more research is required to establish the advantage of using rotary weeding tool as compared to hand in minimizing labour intensity. The results for time required in accomplishing weeding by hand as compared to rotary weeding is as indicated in the table.

First weeding (Time required to accomplish activity)

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	1hour 23 minutes	1 hour 10 minutes	1hour 50 minutes
Rotor	1hour 5 minutes	58 minutes	1hour 25 minutes
Manual	3 hours 10 minutes	4 hours 22 minutes	3hour 27 minutes

Second weeding (time to accomplish operation)

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	2hours 30 minutes	1 hour 58 minutes	2hours 30 minutes
Rotor	2 hours 10 minutes	1 hour 55 minutes	2hour 20 minutes
Manual	5 hours 10 minutes	4hours 46 minutes	3hour 57 minutes

Third weeding (time to accomplish operation)

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	1 hour 45 minutes	1hour 25 minutes	2 hour 20 minutes
Rotor	1 hour 30 minute	1hour 12 minutes	1hour 45 minutes
Manual	4 hour 10 minutes	4 hours 30 minutes	3hour 33 minutes

3.2.2 Measuring of weed intensity

Weed intensity measurement indicated that on manually prepared plots the weed intensity was higher as compared to power tiller prepared plots. For power tiller prepared plots there was also a difference in weed intensity as on plots with plow treatment had higher weed intensity than those of rotor, the reason which brought about this difference is probably on method of land preparation as its possible that with manually prepared plots there was less effect on weed seed burial the same applied to plow treatment but as for rotor treatment it seems that of the method of land preparation used it was more effective in minimizing weed intensity.

Another observation was on variation of weed intensity from first weeding to third weeding, it was observed that the amount of weed for each treatment increased significantly from first to third weeding, and still the manual plot having the highest weed intensity, for all weeding stages. The reason for this situation could probably be due to fertilizer applied which could have supplied adequate nutrients for weeds to flourish well.

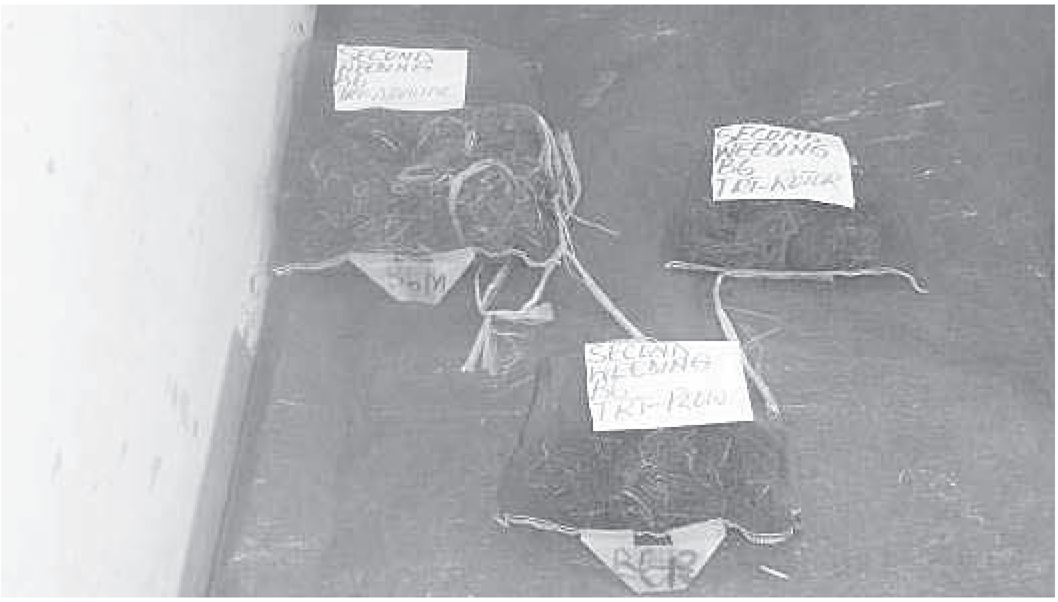
Measuring amount of weed (in unit gram)

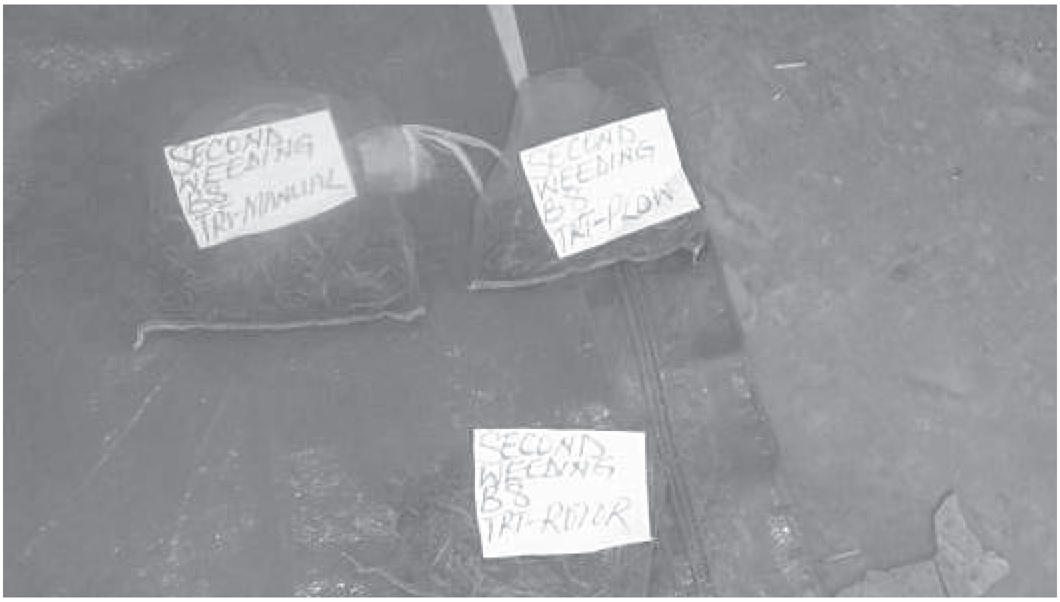
Weeding intensity measure during first weeding

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	14.54	75.8	19.43
Rotor	10.50	22.30	11.25
Manual	60.25	65.98	50.45

Weeding intensity measure during second weeding

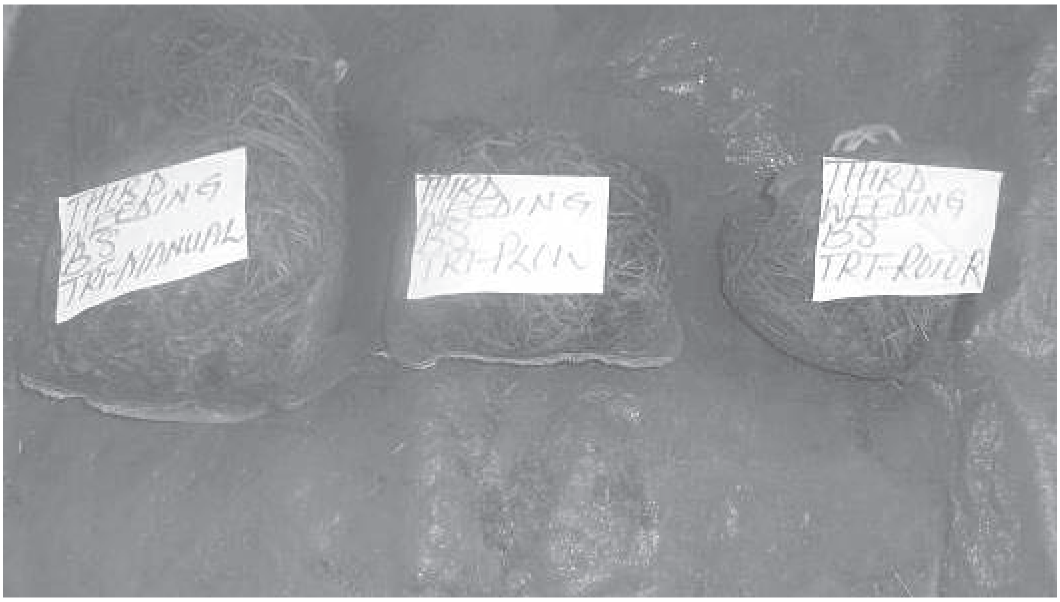
Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	38.15	75.8	35.74
Rotor	35.64	40.00	23.26
Manual	126.20	81.98	111.68





Weeding intensity measure during third weeding

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	232	340.15	140.45
Rotor	142.47	169.19	129.55
Manual	1046.15	384.75	341.57



3.3 Water test

The results of water test showed that the plots with manual treatment had highest water loss as well as highest water consumptive use, the reason behind could probably be, there was higher infiltration rate due to soil being more porous than rotor and plow treatments. It was also found that even the treatments of rotor and plow showed a difference. The treatment of rotor hand less water loss as well as less water consumptive use. This indicates that in rotor treatment probably the soil was highly pulverized and the fine particles (soil colloids) tended to fill the pore spaces of the soil hence minimizing water infiltration into the soil by so doing the water could stay longer in the plots after irrigation.

Water test (average water loss in mm/day)

Day 1

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	18	13	11.7
Rotor	12	8	10
Manual	27	20	21

Day 2

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	17.8	14	12
Rotor	11	7.5	9.5
Manual	33.3	21	20.5

Day 3

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	16	13.1	11
Rotor	9.5	7.5	9
Manual	29	22	20.8

Day 4

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	15.5	14	12
Rotor	10	8	9
Manual	31	20	19

Day 5

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	16	12	11.5
Rotor	9	7.4	8.5
Manual	25	21	18

Day 6

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	15	13	12
Rotor	9.8	7.5	8
Manual	26	20.5	18

Day7

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	14.8	11	12
Rotor	9	7.3	8.3
Manual	24	20	18

Day8

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	14.5	11.3	11
Rotor	9.2	7.2	8.5
Manual	24.5	20.4	17.5

Day9

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	15	11	11
Rotor	9	7	8
Manual	23.8	20	17

Day 10

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	14.8	10.8	10,3
Rotor	8.8	7	8.1
Manual	23	19.5	16.8

Water test (average water loss in M3/day)

Day1

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	48.8	34.7	29.7
Rotor	29.4	21.3	27
Manual	72.6	49.5	55.89

Day 2

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	48.2	37.4	30.5
Rotor	26.9	20	25.67
Manual	89.6	51.9	54.6

Day 3

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	43.4	34.95	27.9
Rotor	23.2	20	24.3
Manual	77.98	54.4	55.36

Day 4

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	42	37.4	30.5
Rotor	24.5	21.3	24.32
Manual	83.4	49.4	50.5

Day 5

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	43.4	32	29.2
Rotor	22.0	19.7	22.97
Manual	67.2	51.9	47.9

Day 6

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	40.7	34.69	30.47
Rotor	23.9	20	21.62
Manual	69.9	50.7	47.9

Day 7

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	40.1	29.4	30.5
Rotor	22.0	19.5	22.4
Manual	64.5	49.5	47.9

Day 8

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	39.3	30.2	27.9
Rotor	22.5	19.2	22.97
Manual	65.5	50.46	46.6

Day 9

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	40.7	29.4	27.9
Rotor	22.0	18.7	21.6
Manual	64.0	49.5	45.2

Day 10

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	40.1	28.8	26.2
Rotor	21.5	19.2	21.9
Manual	61..9	48.2	44.7

3.4 Harvesting test

3.4.1 Cutting rice crop

The activity of cutting the rice crop showed that the plots with manual treatment required more time to cut the crop, as cutting by sickle for a single plot required about 2 hours and 50 minutes whereas for treatments which were for rotor and plow, which were harvested using a ripper each plot took about 23 minutes on average to cut a single plot. The results obtained refers as indicated in the table

Cutting rice (time to accomplish operation)

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	22min	24min	24min
Rotor	26min	23min	21min
Manual	3hrs 16 min	2hrs 32 min	2hrs 58 min

3.4.2 Amount of fuel used in cutting the rice crop

With a short time for the operation of cutting the rice crop, the amount of fuel used was very low. This makes the activity of harvesting using improved machine like ripper to be much cheaper as compared to manual even by hiring the machine, rather than using manual labour.

The results of the amount of fuel used per treatment is as indicated in the table

Amount fuel used for cutting rice

Treatment	Rep 1(b6)	Rep2(b7)	Rep3(b8)
Plow	200mls	215mls	209mls
Rotor	205mls	200mls	204mls
Manual	N/A		

Annex 2

ACTIVITY REPORT ON

INTRODUCTORY TRAINING OF FARMERS ON OPERATION AND SERVICING OF POWER TILLERS IN LIRA, UGANDA

Saasa A. Richard and Okiror Wilson

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

23rd to 29th June 2014

1.0 Introduction

Japan Association for International collaboration on Agriculture and Forestry is providing assistance for Power tiller mechanized Agriculture in Lira district of Uganda. The main objective of this exercise is to promote and popularize two wheel hand tractors and their associated implements.
One of the support activities being undertaken by AEATREC was to conduct introductory training of farmers on operation and servicing of power tillers in Lira, Uganda

The activity was done from 23rd to 29th June 2014.
The activity was conducted by Saasa A. Richard (Team leader) and Okiror Wilson as Power tiller technician.
The training was attended by Mr Okullo Peter and his two operators. Table 1 below gives details of the trainers and Trainees

No	Name	Title	Institute
1	Saasa A. Richard	Engineer	AEATREC
2	Okiror Wilson	Technician	AEATREC
3	Okullo Peter	Farmer	Lira District
4	Okec Job	Trainee	Okullo's operator
5	Opio Jasfer	Trainee	Okullo's operator
6	Alele Fred*	Trainee	Lira District
7	Otim Ayuta*	Trainee	Lira District

Trainee did not complete the training

2.0 Purpose and objectives of the training

The purpose of the training was to impart skills and knowledge on operation and servicing of power tillers.
The objectives of the training were to:
- Introducing power tiller to participants
- Preparing a power tiller for work
- Practice on starting/walking with Power tiller
- Driving, transporting produce/ building materials with a power tiller
- Mounting mould board plough and Ploughing with power tiller
- Mounting a disc plough and Re-Ploughing with power tiller
- Practice daily cleaning and servicing of Power tiller

3.0 Course content

The training covered the following topics and practices:
a. Understanding, Identifying and naming parts of power tiller
b. Preparing a power tiller for work
c. Practice on starting/walking with Power tiller
d. Practices on driving, transporting produce/ building materials
e. Practices on mounting mould board plough and Ploughing
f. Practices on mounting a disc plough and Re-Ploughing with power tiller
g. Practice daily cleaning and servicing of Power tiller

4.0 Equipment used during training

These included Power tiller, Trailer, Mould board plough and Disc plough (figure 2 below).

Figure 2: Equipment used during training

5.0 Training methodology

The training was on-job. It combined minimal explanation with actual practices.

5.0 Practices done by Participants

5.1 Identifying and naming parts of the tiller

Participants were taken through identifying and naming parts. Vital parts identified included engine, gear box, handles and frame. They also identified fuel tank, water tank, fuel filter, oil filling and draining points, fuel movement and cylinder head. The functions of each part were explained to participants. They further learnt the clutch lever and accelerator lever so as to be able to control the tiller during operations.

Figure 3 Trainees Identifying tiller parts

5.2 Starting and walking with power tiller

Procedure of starting and stopping of tiller was explained and thoroughly demonstrated to participants. Every participant practiced starting (figure 4) and stopping the tiller until he/she proved confident. This was then followed by walking with the tiller to build trainees' confidence in controlling the tiller (figure 5).

Figure 4: Trainees practice starting power tiller

Figure 5: Trainees practice walking with power tiller

5.3 Driving power tiller

During this exercise, an empty trailer was hitched onto the tiller. The tiller was started and both trainer and each trainee sat and guided to drive and control the tiller. They were later subjected to reversing and packing in restricted areas.

Finally the participants took turns to practice reversing and parking in restricted areas. Figures (6) show participants driving and reversing using the tiller.

Figure 6: Trainee practice driving power tiller

5.4 Setting Mouldboard plough and ploughing

Participants learnt that the purpose of ploughing was to destroy weeds, loosen soil to allow air and water penetration for easy plant growth and make field easy for planting. It was also explained that during ploughing cage wheels are used instead of tyre to minimize slippage. Mounting of cages and removing of tires was demonstrated and the rest of participants removed tires and fitted cages onto their tillers (figure 3g - h). They mounted and set both the mould boards and disc ploughs (figure 3i - j). Two techniques of ploughing (gathering and casting) were demonstrated to participants. Trainers explained that the two methods are used alternatively to avoid heaping soil or creating a valley in the middle of the field (Figure 7a -d). Each operator ploughed 0.5 acres

Figure 7a

Figure 7b

Figure 7c

Figure 7d

Figures 7a-d: Trainee practice ploughing using power tiller

5.5 *Mounting a Disc plough and Ploughing*

Mounting and setting a disc plough was demonstrated to participants. This was followed by individual practices on actual ploughing using disc plough (figure 8).

Figure 8: Trainee re-ploughing using disc plough

5.6 *Practice on Servicing and maintenance of Power tiller*

Here participarts Identified Power tiller parts that need Servicing and changed oil, greased nipples, and changed tyres and fixed cage wheels (figure 9)

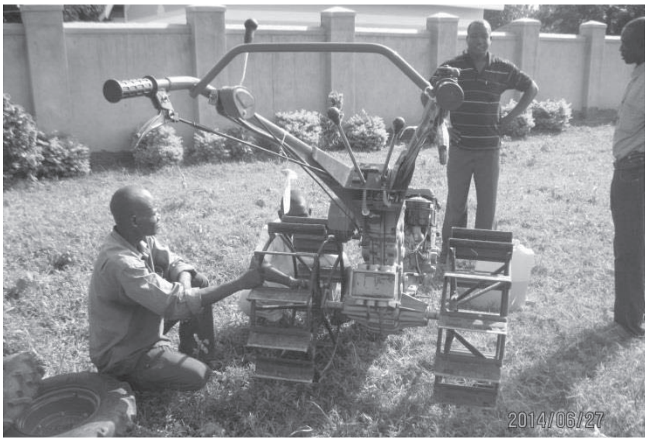


Figure 9: Trainees fixing cage wheels

6.0 Conclusion

Training was done successfully and enhanced participants' skills on operating the power tiller. However there is need for trainees to continue practicing to improve and better their skills

Annex 3

REPORT ON

MAKING AND DELIVERY OF POWER TILLER HARROW, TRAINING ON HARROWING AND REPAIR OF POWER TILLER TRAILER

Okurut Samuel and Olupot Joseph

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

16th – 19th July 2014

Activity Title: Making and Delivery of Power Tiller Harrow, Training on Harrowing and Repair of Power Tiller Trailer

Activity Leader: Okurut Samuel

Participating Team	Title	Institution
1. Okurut Samuel	Engineer	AEATREC
2. Olupot Joseph	Technician	AEATREC
3. Okullo Peter	Farmer	Lira District
4. Okec Job	Operator	Lira District
5. Takahata Tsuneo	Technical Advisor	JAICAF
6. Nishikawa Nanami	Field Assistant	VSOC

Dates of mission: 16th to 19th July 2014

1.0 Introduction

In a bit to enhance promotion of mechanized rain fed rice farming using small agricultural machinery such as the two wheeled hand tractor, its attachments, AEATREC is supporting JAICAF in its feasibility survey test on suitability and efficiency of small agricultural machinery in Lira district in Uganda. One of the support activities being undertaken by AEATREC was making and delivery of power tiller harrow, training on harrowing and repairs of power tiller trailer. This activity was carried out during the period 16th to 18th July 2014 and could not continue till 19th July 2014 due to mechanical problems encountered by the Power Tiller on the 17th July 2014 at the upland rice field.

2.0 Activities carried out

Four tasks were carried out during the mission. They included:

1. Making of Spiked toothed Triangular Harrow,
2. Delivery of the Harrow to farmer in Lira,
3. Training of farmer and operator on Harrowing using the harrow and
4. Repair of Power Tiller Trailer

3.0 Field location

Training of the farmer and operator was undertaken right at the field site in Lira. Details of the field location are provided in table 1.

Table 1: Details of field location

Village	Parish	Sub county	District
Opuwakere LC1	Boke	Adekokwok	Lira

While trailer repairs was undertaken from a near-by private workshop close to the farmer's home. Location details for the workshop are provided in table 2 below.

Table 2: Details of Workshop location

Name of workshop	Village	Sub county	District
Akitenino Youth Metal Fabrication	Adyel Division LMC	Lira Municipal Council	Lira

4.0 Results

4.1 Spiked toothed Triangular Harrow

One unit of a Spiked Toothed Triangular Harrow was fabricated at the AEATREC and delivered to the farmer (Mr. Okullo Peter) in Lira. The purpose of the harrow was to break the big soil particles into fine particles in order to effective use the seeder for seeding rice.

4.2 Training on the Harrow and Harrowing

The training was purely practical and carried out directly at the farmer's field in Opuwakere LC1. It involved learning the harrow and its main parts, hitching adjustment on the implement, procedures on how to set and adjust harrow and to practically carrying out the harrowing operation.

During the training on the harrow, it was noted that the field still required being re-plowed. The farmer was advised to carryout re-plowing of the field before harrowing it.

After re-plowing the field, the farmer used the harrow but it did not work effectively for harrowing because it is wide to the extent that the operator legs knock on it during operation. This made controlling and maneuvering the tiller with the harrow mounted on it very difficult. In addition trash gets clogged on to the spikes thus making it ineffective.

Field being re-plowed by Mr. Okec the operator

Proposed solutions to harrowing problems

- Modify the harrow to re-sizing it to prevent knocking the legs of the operator during operation.
- Align the spikes so that they allow trash not to be clogged on it.
- Explore, source and adapt other available alternative designs of harrows that can be used for upland field operations

4.3 Repair of Power Tiller Trailer

Figures 1a to 1g show pictures during repair of the Trailer.

Figure 1a: Takaha shows Joseph to make some adjustment on clutch

Figure 1b: Takaha and Nanami at Akitenino Youth Metal fabrication workshop before Trailer repair

Figure 1c: Trailer at Akitenino Youth Metal Fabrication workshop

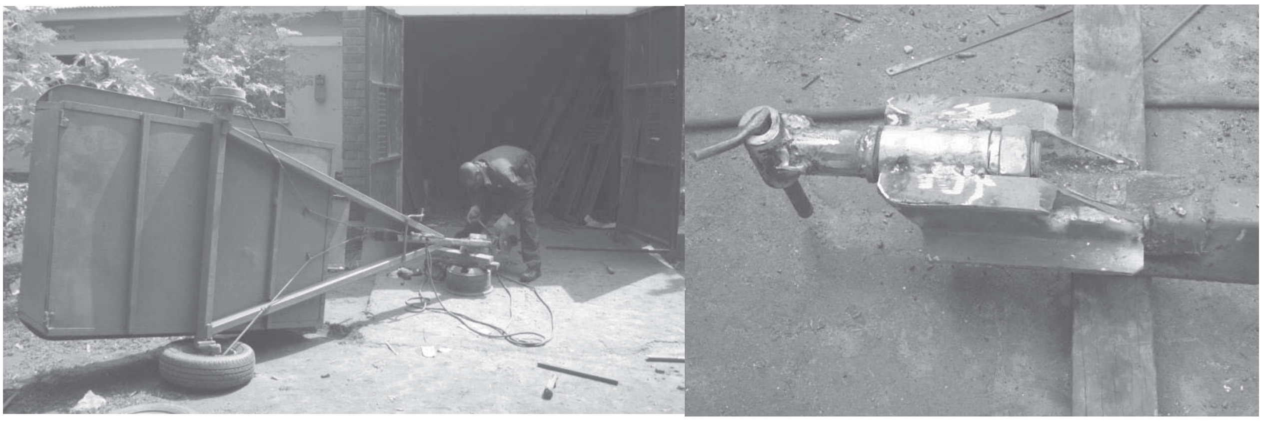


Figure 1d: Left: Joseph welding the Trailer hitching unit. Right: Welded hitch unit

Figure 1e: Ms. Nanami talking to workshop technicians about their work

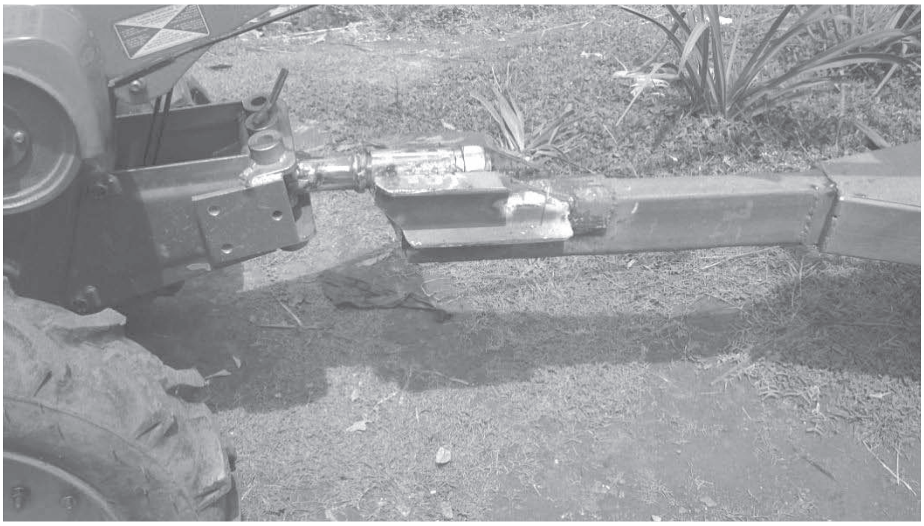


Figure 1f: Trailer hitched to the Power Tiller to check if it's okay

Figure 1g: Trailer repair completed and ready to leave workshop

6

5.0 Observations and Conclusion

5.1 Observations

Farmer and Operator showed the AEATREC and JAICAF team the state of the wet lowland fields which are to be cultivated. Below are the pictures.

1. Left picture shows wet land field ploughed but flooded with water.
2. Right picture shows wet land field not ploughed but flooded.

On the 17th July 2014, the Power Tiller encountered clutch imbalance problem and at some point total failure that almost resulted into a fatal accident. As a result the harrowing activity could not be done and the Power Tiller had to be packed at the home of Peter's late father.

5.2 Conclusion

The Trailer was successfully repaired and working well. A decision was arrived at following consultants between AEATREC and JAICAF to transport the Power Tiller back to Kampala to FEIL to rectify the fault.

6.0 Way forward

1. FEIL rectifies the problem on Power Tiller and have it delivered back to the farmer or FEIL delivers another Power Tiller unit so that field activities continue smoothly.
2. Sourcing and adapting alternative harrow designs that can be field tested to assess their effectiveness and suitability for carrying out harrowing operations for upland fields.

Annex 4

REPORT ON

SUPERVISION AND TRAINING OF FARMER AND OPERATOR ON SEEDING RICE WITH POWER TILLERS IN LIRA, UGANDA

Okurut Samuel and Okiror Wilson

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

27th – 30th August 2014

Activity Title: Supervision and Training of Farmer and Operator on Seeding Rice with Power tiller

Activity Leader: Okurut Samuel

Participating Team	Title	Institution
1. Okurut Samuel	Engineer	AEATREC
2. Okiror Wilson	Technician	AEATREC
3. Okullo Peter	Farmer	Lira District
4. Okec Job	Operator	Lira District

Dates of mission: 27th to 30th August 2014

1.0 Introduction

In a bit to enhance promotion of mechanized rain fed rice farming using small agricultural machinery such as the two wheeled hand tractor, its attachments, AEATREC is supporting JAICAF in its feasibility survey test on suitability and efficiency of small agricultural machinery in Lira district in Uganda. One of the support activities being undertaken by AEATREC was supervision and training of farmer and operator on seeding rice using a multi-row multi-crop seeder mounted on to a power tiller. This activity was carried out during the above period.

The training was purely practical and carried out directly at the farmer's field. It involved learning the various parts of the seeder and their functions, procedures on how to set and adjust planting row width, seed rate, maneuvering the seeder and practically carrying out the seeding operation.

2.0 Objectives of Supervision and Training

The objective of supervision was to provide technical back stopping to the farmer and his operator on all issues related to use and proper operation of the power tiller and its attachments.

The specific objectives of training farmer and operator on Seeding Rice with Power tiller was to impart relevant skills in proper use and operation of the seeder and to conduct seeding of his rice field together with him and his operator.

3.0 Field location

Training of the farmer and operator was undertaken right at the field site in Lira. Details of the field location are provided in table 1.

Table 1: Details of field location

Village	Parish	Sub county	District
Opuwakere LC1	Boke	Adekokwok	Lira

The training of the farmer and operator was combined with actual work that involved planting of rice using a multi-crop seeder. The seeder was mounted on to the Yanmar single axle tractor, equipped with a 9 HP diesel engine.

4.0 Results

Parameter	**Result**	**Remarks**
Total area of field ploughed and harrowed	1.4055 acres	
Variety rice planted	NAMCHE-1	
Type of operation	Seeding rice	
Type of implement	Multi-row multi-crop seeder	
Number of rows seeded	3-rows	
Date of seeding	28th August 2014	
Seeding Row spacing done	36 cm	Instead of 30cm to avoid tires stepping on rice crop and damaging it during weeding. 36cm accommodates use of caged wheels to provide adequate traction
Working time	02:37:35	
Total lap time	02:33:24	
Average lap time	02:33:24	
Area planted	1.3795 acres	
Amount of seed used during planting	43.5 kgs	
Field conditions: Soils	Normal	
Field conditions: Weed	Clear	
Field conditions: Moisture	Mildly moist	
Line Marker	Non	Marking of caged wheels used
Weather	Sunny and Cloudy	It rained after seeding
Fuel used	1.5 Liters	
Speed shift	L1	
Number of persons trained	2	Farmer and Operator

Figures 1a to 1d show pictures during training and seeding of rice.

Figure 1a: Namche-1 rice variety

Figure 1b: Measuring seed to put in the seeder hoper

Figure 1c: Mr. Okullo pours seed into the seed hoper

Figure 1d: Mr. Okiror demonstrates to Mr. Okec seeding of rice

Seeder set and ready for seeding

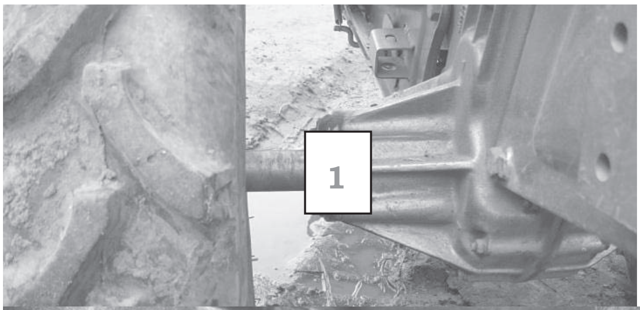
Mr. Okec seeding rice as Mr. Okrior observes during training

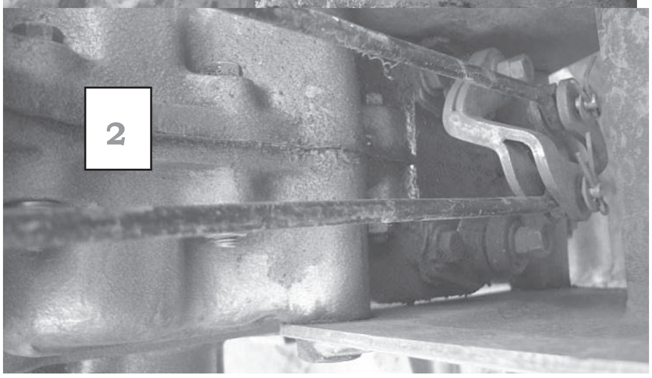
Mr. Okec seeding rice alone after training

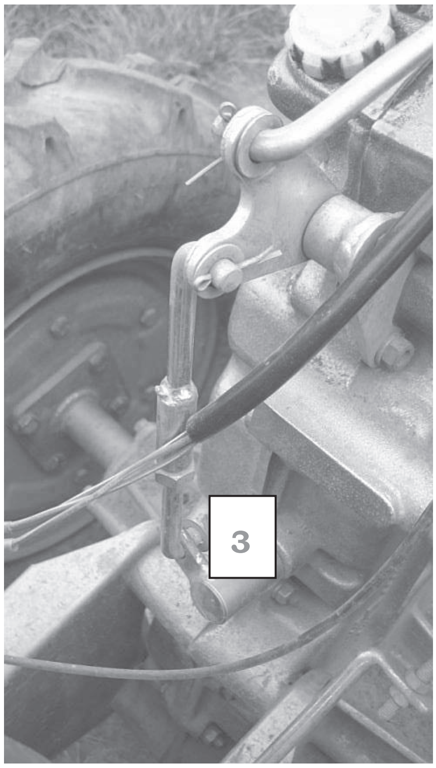
5.0 Observations and Conclusion

5.1 Observations

Farmer and Operator showed the AEATREC technical team some of the concerns on the power tiller which need attention. Below are the pictures.







1. Top left picture shows a leakage on the hub.
2. Bottom left picture shows a leakage on transmission case
3. Right hand picture shows transmission gear lever disengages

5.2 Comment on Seeding machine

- Furrow openers are weak and they got bent and twisted

5.3 Conclusion

The Power tiller was able to seed rice 3-rows at a time using the multi-row multi crop seeder. The skill of the farmer and operator in seeding rice still requires to be improved.

6.0 Way forward

- Need to conduct more trainings on seeding to improve and perfect operator skills.
- Need to modify and strengthen furrow openers with strong steel materials to avoid deformations during working.

Annex 5

ACTIVITY REPORT ON

SUPERVISION AND TRAINING OF A FARMER AND HIS OPERATORSON WEEDING OF RICE USINGA POWER TILLER IN LIRA, UGANDA

Saasa A. Richard and OkirorWilson

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

30thSeptember–4th October 2014

1.0 Introduction

Japan Association for International collaboration on Agriculture and Forestry is providing assistance for Power tiller mechanized Agriculture in Lira district of Uganda. The main objective of this exercise is to promote and popularize two wheel hand tractors and their associated implements.
One of the support activities being undertaken by AEATREC was supervision and training of farmer and operator on weeding row planted rice using a power tiller weeder.

The activity was done from 30th September to 4th October 2014.

The activity was conducted by Saasa A. Richard (Team leader) and Okiror Wilson as Power tiller technician.
The training was attended by Mr Okullo Peter and his two operators. Table 1 below gives details of the trainers and Trainees.
Table 1: Details of participants

No	Name	Title	Institute
1	Saasa A. Richard	Engineer	AEATREC
2	Okiror Wilson	Technician	AEATREC
3	Okullo Peter	Farmer	Lira District
4	Okec Job	Operator	Lira District
5	OpioJasfer	Operator	Lira District

2.0 Purpose and objectives of the training

The purpose of the training was to impart skills and knowledge to the farmer and his operators on weeding using a power tiller pulled weeder.
The objectives of the training were to:
- Identify and name main parts of a weeder
- Demonstrate mounting and setting a weeder
- Practices actual weeding using a power tiller weeder
- Determine the rate of weeding and fuel consumption of the power tiller.
- Practice daily cleaning and servicing of Power tiller

3.0 Course content

The training covered the following topics and practices:
a. Identifying and naming parts of the weeder,
b. Mounting of weeder on power tiller and adjusting of the weeder,
c. Proper handling and controlling of the weeder during weeding,
d. Demonstration and Practices on weeding,
e. Determining the rate of weeding and fuel consumption and
f. Practices on daily maintenance of the weeder

4.0 Training methodology

The training was on-job. It combined with actual work that involved planting of rice using a multi-crop seeder. The weeder was mounted on to the Yanmar single axle tractor, equipped with a 9 HP diesel engine.

The farmer and his two operators were first taken through weeding open field to enable them gain skills in maintaining straight line. The necessary adjustments were made to enable the tire move in rows without stepping on the rice crop. Each operator was accorded opportunity to try out and carry out weeding operation of 4 rows before actual timing was conducted.

5.0 Weeding Results

Table 2 gives the results of Weeding.

Table 2: Weeding performance results

Parameter	**Results**
Type of weeder	Two- row weeder with duck foot sweeps
Variety rice planted	NAMCHE-1
Inter row spacing (average)	36 cm
Field conditions: Soils	Normal
Field conditions: Weed	Lightly infested with weeds (Figure 1a-d)
Field conditions: Moisture	Mildly moist
Weather	Sunny and Cloudy
Performance of Operator 1	
Area wed	90mx55m = 4950m^2=1.24 acres
Time taken	3hrs 55min
Fuel used, Diesel (liters)	550ml=0.55l
Weeding rate	0.574 Acres/hr/litre of diesel
Speed shift	L1
Performance of operator 2	
Area weed (m^2)	70mx64m =4480m^2= 1.12acres
Time taken	3 hrs, 20 minutes=
Fuel used (liters)	0.5
Weeding rate	0.672 Acres/hr/litre of diesel
Speed shift	L1
Number of participants trained	3 persons (Farmer and 2 operators)

Figures 1a to 1d: show weed infestation in different portions of Farmer's field.

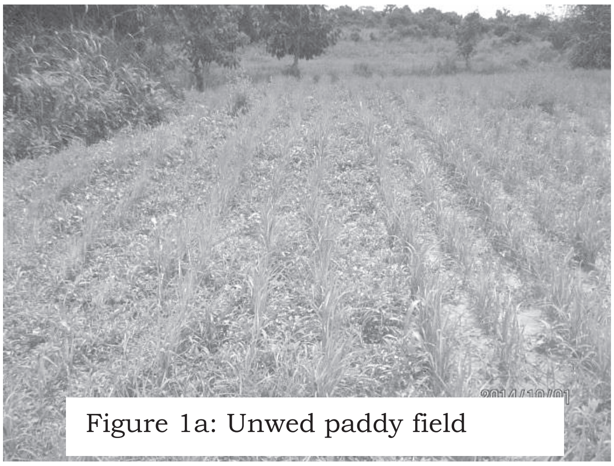


Figure 1a: Unwed paddy field

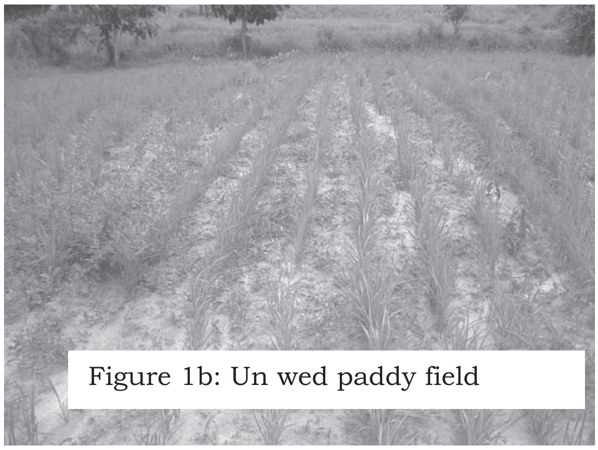


Figure 1b: Un wed paddy field

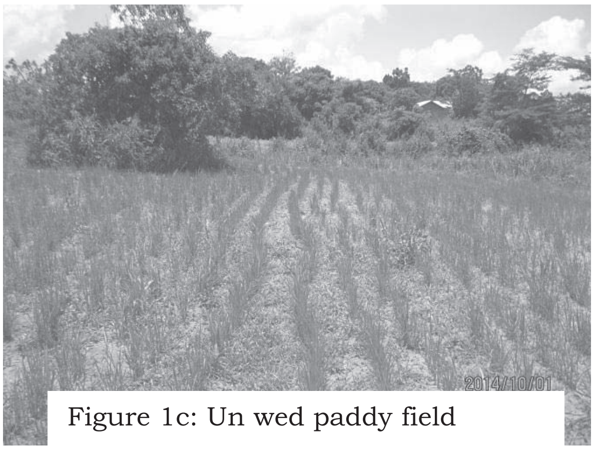


Figure 1c: Un wed paddy field

Figure 1d: Un wed paddy field

Figures 2a and 2b show trained operator weeding Paddy field

Figure 2a

Figure 2b

Figure 3a- show wed paddy field

Figures 4a and4b ShowTrainees weeding with power tiller

Figure 4a   Figure 4b

6.0 Conclusion

Weeding exercise was done successfully. However there is need to do second weeding.

Okech exhibited better skills and could manipulate the tiller with weeder mounted on it properly. He was stable, worked fast and managed to do the weeding well.

Opio was relatively less skilled in carrying out weeding operation due to not being acquainted with the use of the tiller. Consequently he was slow during work and not very stable.

Both operators were very interested in carrying out the weeding operation.

The weeder performed well and was able to weed 2-rows at a time. However, the weeder tines got deformed in working in hard soils.

7.0 Recommendations

Weeding operation needs to be done early in time (timely) when the weeds are still young and tender in order to have clean garden. This would also facilitate easy use of the weeder.

The operators need to do more practice in weeding more fields in order to perfect their skills and cope up with conducting weeding operation properly. This requires time to be achieved.

There is need to strengthen the weeder tines as they showed deformation in hardsoils.

The current price of the weeder is UGX 650,000. The recommendable appropriate price for the weeder could be UGX 450,000.

REPORT ON

DEMONSTRATION OF POWER TILLER AND ASSOCIATED EQUIPMENTS IN DISTRICTS OF OTUKE, ALEBTONG AND LIRA IN UGANDA

Saasa A. Richard, Kyomukama Alex Okiror Wilson and Okullo Peter

Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

4th to 6th December 2014

1.0 Introduction

Japan Association for International collaboration on Agriculture and Forestry is providing assistance to promote and popularize power tillers and their associated implements in Uganda. A Three days (4-6th December 2014) demonstration was conducted in the districts of Otuke, Alebtong and Lira. The purpose of the demonstration was to create awareness among farmers on Power tillers and their associated implements. The selection of the said districts was due to willingness of the farmers to try out new technologies, farmers are involved in large scale growing of rice, available large sizes of suitable land for cultivation purposes, access ability to the new technology by other neighboring districts and political will of the district leadership.

2.0 Equipment demonstrated

The equipment demonstrated included the following:

i. Yanmar power Tiller
ii. Mouldboard plough
iii. Disc Plough
iv. Planter
v. Weeder
vi. Trailer
vii. Water pump
viii. Paddy Reaper
ix. Paddy thresher

3.0 Demonstrating team

Demonstration was conducted by Saasa A. Richard (Team leader), Okiror Wilson as Power tiller technician. They were supported by Dr Takahata from JAICAF, Mr Kawachi S of 3WM Ultd and Okullo peter, a farmer using a power tiller in Lira district

Table 1: Details of demonstration team

No	Name	Title	Institute
1	Saasa A. Richard	Engineer	AEATREC
2	Okiror Wilson	Technician	AEATREC
3	Dr Takahata	Expert	JAICAF
4	Kawachi S.	Director	3WM (U) Ltd
5	Otai Joseph	Sales person	3WM (U) Ltd
3	Okullo Peter	Farmer	Lira District
4	Okec Job	Operator	Lira District
5	Opio Jasfer	Operator	Lira District

4.0 Demonstration arrangement

Prior to demonstrations, Radio announcements were made in local languages inviting farmers to attend live demonstration of power tiller technology on 4th December 2014 at Adwari Village Otuke district, 5th December 2014 at Alebtong district and 6th December 2014 at Amach lira district.

This was followed by two live talk shows about power tiller technology and demonstrations to be held on 4th, 5th and 6th in the districts of Otuke, Alebtong and lira respectively.

During the demonstrations, a public address system was used to further invite and talk to farmers. Farmers were showed how each equipment works and eventually accorded opportunity to try out the equipment and ask questions.

5.0 Attendance of farmers in Adwari, Otuke district during demonstration

More than 150 farmers attended and participated in the demonstration in Adwari, Otuke district. Figures 2a-d show farmers trying various machines

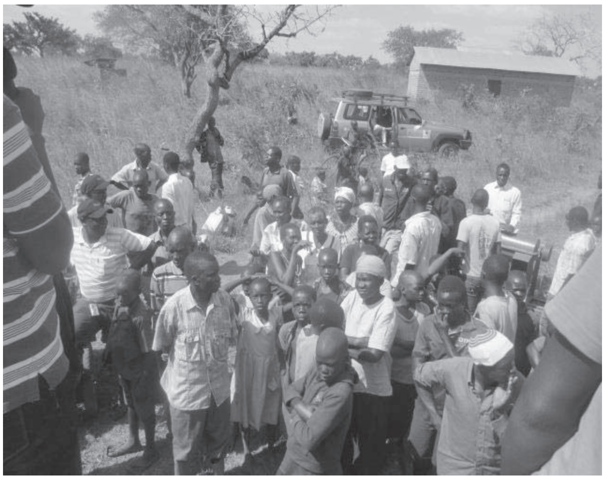


Figure 1a: Farmers listen to announcements in Adwari

Figure 2b: Farmers try out power tiller

Figure 2c: Farmer try out power tiller

Figure 2b: Farmers ploughing with power tiller

6.0 Attendance of farmers in Alebtong during demonstration

More than 250 farmers attended and participated in the demonstration in Alebtong district. Figures 2a-d show farmers trying various machines

Figure 2a: Farmer try out power tiller

Figure 2b: Farmer try out power tiller

Figure 2c: District Agricultural Officer Ploughs with Power tiller

Figure 2d: Farmers observe and admire ploughed using power tiller

7.0 Attendance of farmers in Alebtong during demonstration

More than 200 farmers attended and participated in the demonstration in Amach Lira district. Figures 3a-d show farmers trying various machines

Figure 3a: Female farmer harvesting paddy using a reaper

Figure 3b: Farmers shell Maize with Power tiller

Figure 3c: Demonstration of planting using Power tiller

Figure 3d: Farmers participate in paddy threshing

8.0 Question and Answer Session

At end of every demonstration, farmers were given opportunity to ask questions. Questions were grouped into either technical or Business. All technical questions were answered by Eng Saasa while business ones were responded to by director 3WM (U) ltd. Table 2 gives the details.

No	Farmers questions (Otuke, Alebtong and Lira)	Responses
Technical questions	What standard implements (Package) are provided with Power tiller on purchase	When you buy a power tiller you are provided with 2cage wheels, 2 tyres, 1.Mouldboard plough and disc plough. Gradually you can later buy a trailer, planter, weeder, and water pump based on your needs
	What is its fuel consumption	Average fuel consumption 4litres/acre
	Apart from paddy, Can it also plant beans, maize and Simsim?	The planter plants paddy, beans, Maize but not yet tried on simsim.
	Are the spare parts available and where can one get them	Spare parts are available with dealers (FEIL and 3WM (U)ltd
	Where can one get maintenance /repair services?	Repairs services can be got from Dealers (FEIL/3WM (U)Ltd AEATREC plans to train local mechanics in Lira to offer needed services Complicated repairs can be refered to AEATREC Namalere
	Where does one get training on operation of tiller and implements?	Training can be got from: a) Okullo peter + his operators b) Dealers (FEIL and 3WM (U) ltd c) AEATREC Namalere
Business Questions	What is cost of the power tiller	11-14 million shs depending on Implement attachments needed
	Can one pay in Installment?	Yes. First Installment 50% and the rest on delivery.

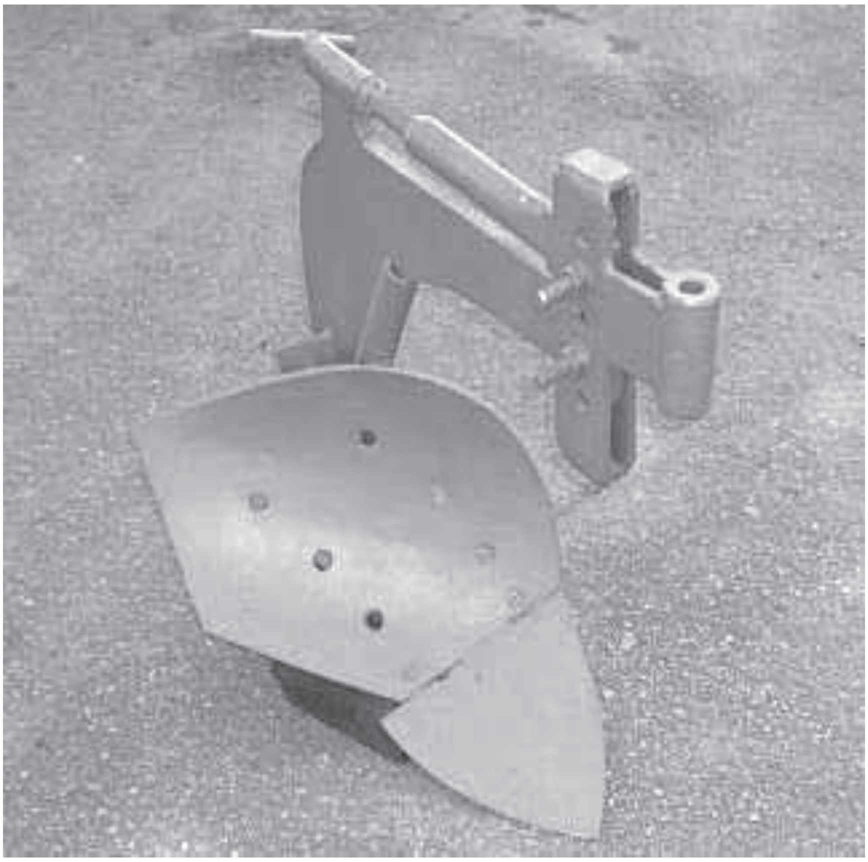
9.0 Conclusion

Demonstration was successful and exposed power tiller machineries to more than 600 farmers. At least more than five farmers exchanged contacts with 3WM (U) Ltd and expressed interest to deposit cash to purchase the power tillers.

REPORT ON

AEATREC MODIFIED POWER TILLER MOULDBOARD PLOUGH

Okurut Samuel and Saasa A. Richard



Funded by Ministry of Agriculture, Forestry and Fisheries of Japan

February 2015

1.0 DESCRIPTION OF MODIFIED PLOUGH

The AEATREC Modified Power Tiller (PT) Mouldboard Plough is all steel made. It consists of main beam, share blade, mould board, the hitching system and adjusting handle. Both share blade and mould board are mounted on the land side. At the rear end of the land side is fixed a heel that helps to protect the wearing of the land slide and also helps to set suction angle of the share blade. During operation, the plough is mounted at the rear of the power tiller and the depth of ploughing is regulated using the adjusting handle.

2.0 HISTORICAL DEVELOPMENT OF THE PLOUGH

AEATREC PT Mouldboard Plough is a modification of the Siam Kubota single bottom mouldboard plough. Its development dates back to 2005 when the Government of the Republic of Uganda procured 50 units of power tillers together with standard implements from Siam Kubota Industry Co. Ltd (SKI) of Thailand. Among the standard implements was a single bottom mouldbard plough.

The Siam Kubota mouldboard plough was designed in such a way that all the soil working parts were fully welding onto the beam. This arrangement posed a difficulty of replacing the worn out soil working parts. As a result, it rendered the plough not to be useful any more once the soil working parts are worn out.

AEATREC received concerns from beneficiary farmers about various aspects of the Kubota Power Tiller mouldboard plough that needed to be improved in order for them continue using it for ploughing. Their concerns included difficulty to replace the mouldboard and share when they are worn out, weak beam, problem with adjusting screw and heel.

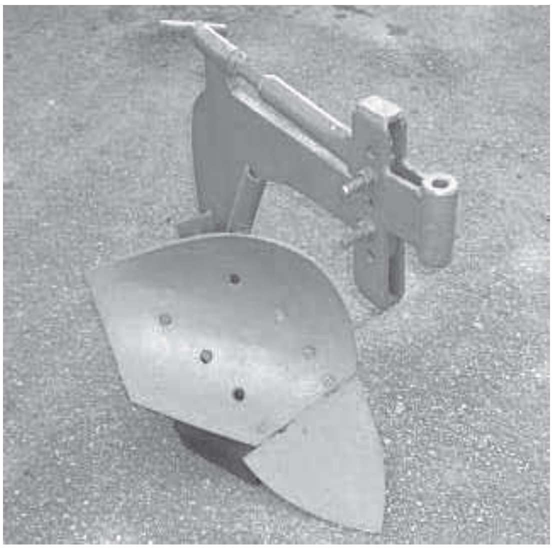
The modifications on the AEATREC plough therefore included providing for easy replacement of the mouldboard and share, improving the strength of the beam, providing for easy adjusting of the screw by having square threads, improving the curvature of the mouldboard for proper inversion of ploughed soil slices and having a land slide heel with improved ware resistant material properties which do not ware off within a short period of time during use.

3.0 Yanmar PT Mouldboard plough and AEATREC Modified PT Mouldboard Plough

3.1 Yanmar PT Mouldboard Plough

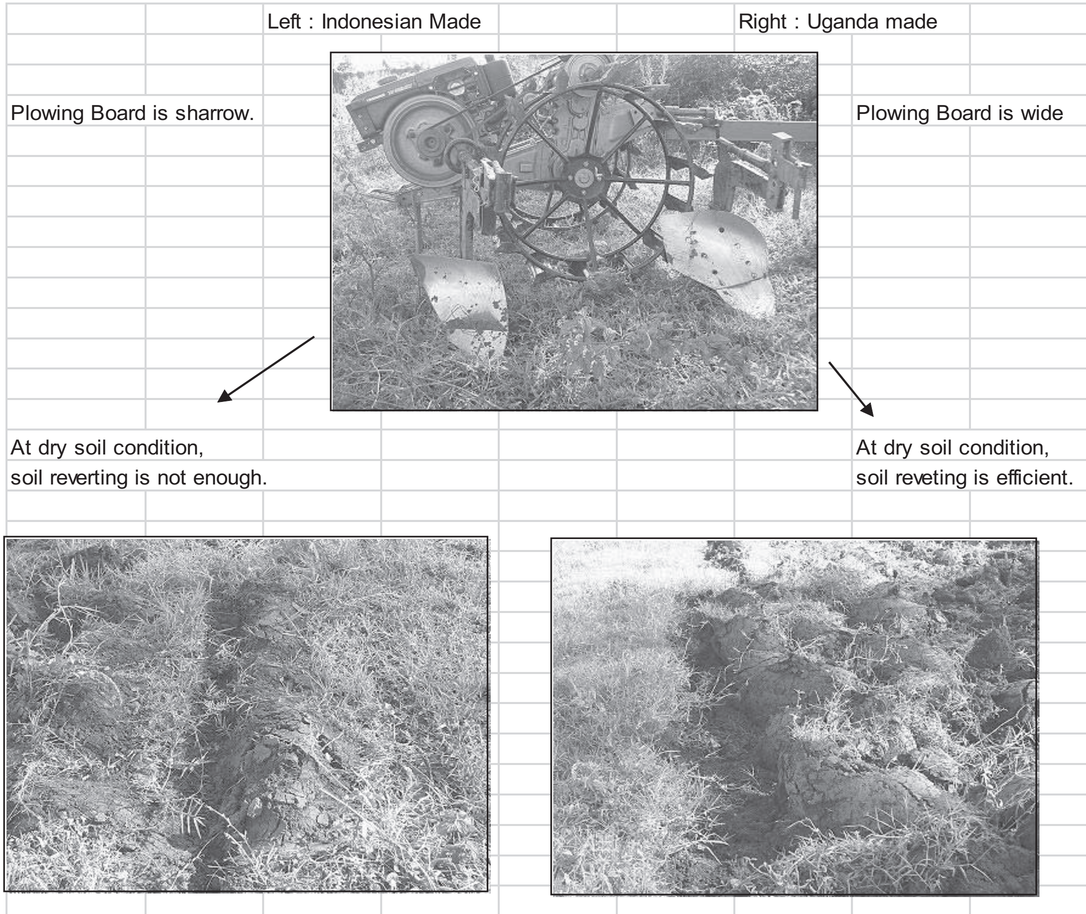
Number of bottoms	-	1
Width of mouldboard	-	245 mm
Length of mouldboard	-	450 mm
Length of shear	-	230 mm
Width of shear	-	210 mm
Length of land side	-	390 mm
Length of beam	-	420 mm
Net weight	-	22 kg

3.2 AEATREC Modified PT Mouldboard Plough



Number of bottoms	-	1
Width of mouldboard	-	350 mm
Length of mouldboard	-	460 mm
Length of shear	-	235 mm
Width of shear	-	215 mm
Length of land side	-	400 mm
Length of beam	-	450 mm
Net weight	-	19 kg

3.0 Comparative Performance of the AEATREC Modified and Yanmar PT Mouldboard Ploughs



Discussion

The Yanmar mouldboard plough had poor soil inversion and leaves unploughed land (ridges). Curvature and size of edge of mould board was found to be small. The small size and poor curvature of the mouldbaord made it difficult to invert the soil properly and left unploughed land. The plough did not perform well particularly in the upland areas.

The AEATREC modified mouldboard plough performed better in both lowland and upland areas. It had good soil inversion and does not leave any unploughed land. The width of cut varied from 25-30cm.

4.0 Conclusion

The AEATREC modified mouldboard was more superior in performance compared to the Yanmar mouldboard plough and was preferred by the farmers. It is currently the one being used by farmers with power tillers.

Report of the Feasibility Survey of Agricultural Mechanization in Lira

Okullo Paul Peter

Introduction

Japan Association for International Collaboration of Agriculture and Forestry (JAICAF) is currently conducting a feasibility survey on Agricultural Machinery in Lira district as a mean of introducing labor saving technology, enhancement of productivities and quality control, and has entrusted part of the survey to Mr. Okullo Paul Peter. The main mechanization machine is the Japanese power tiller (Yanmar Bromo DX) with its assorted implements including ploughs, planter, weeder etc. The main enterprise for this survey is rice production, and is suppose to be done in at least a land size of 1 hector as a survey field and also provision of a hire services to the nearby farmers. There are other stake holders in this feasibility survey with different roles and responsibilities and these includes; 3WM, AEATREC and FEIL among others.

Brief Highlight on Activities:

1. **Identification of Survey Field:** The main field for feasibility survey for upland rice is located at **Gwengabara** 3.7 km south of Lira town and its measuring 1.4 acres of land. After realizing that the land in Gwengabara is quite smaller than what is put in the plan, I decided to again locate another land in **Akia** about 5km east of lira town measuring 1acre to add to the first location in gwengabara. Thus I now have 2 upland rice field and these are:

    - **Gwengabara**: am referring to as; 1st upland field.
    - **Akia**: am referring to as; 2nd upland field.

    Lowland field: I had earlier on located the lowland field for the feasibility survey at Omito parish in Lira sub-county, where I am producing paddy rice with some farmers in that community. It is unfortunate that the land had ever since been flooded to the extent that the power tiller could not be operated inside the garden, thus nothing has so far been done up to now.

2. **Power tiller operations:** The PT operations have been both at the feasibility survey field and for hire services. The details are as in the table below:

Date	Owner of field	Location	Size	Activities	Remarks
10 July 2014	Okullo Peter	Gwengabara	-	Land opening	Survey field
11 July 2014	Okullo Peter	Gwengabara	-	Land opening	Survey field
12 July 2014	Okullo Peter	Gwengabara	-	Land opening	Survey field
7 Aug 2014	Okullo Peter	Gwengabara	1 acres	2nd plowing	Survey field
8 Aug 2014	Okullo Peter	Gwengabara	0.4 acres	2nd plowing	Survey field
11 Aug 2014	Okullo Peter	Akia	1 acre	1st plowing 2nd upland field	Survey field
15 Aug 2014	Olwol Ben	Amac	2.3 acres	Planting upland rice	Hire service
18 Aug 2014	Okullo Peter	Akia	1acre	Planting 2nd upland field	Survey field
19 Aug 2014	Florence	Aber	1 acre	Planting upland rice	Hire service
22 Aug 2014	Okullo Peter	Gwengabara	1.4 acres	3rd plowing 1st upland field	Survey field
28 Aug 2014	Okullo Peter	Gwengabara	1.4 acres	Planting 1st upland field	Survey field
6 Sept 2014	Ireda P.7 Sch	Ireda	1.8 acres	Plowing	Hire service
8 Sept 2014	Ireda P.7 Sch	Ireda	1.5 acres	Plowing	Hire service
9 Sept 2014	Ireda P.7 Sch	Ireda	1.5 acres	Plowing	Hire service
10 Sept 2014	Ireda P.7 Sch	Ireda	1.5 acres	Plowing	Hire service
11 Sept 2014	Ireda P.7 Sch	Ireda	1.5 acres	Plowing	Hire service
17 Sept 2014	Alele Fred	Barr	1 acre	Plowing	Hire service
18 Sept 2014	Alele Fred	Barr	1 acre	Plowing	Hire service
19 Sept 2014	Alele Fred	Barr	2 acres	Planting sunflower	Hire service

3. **Situational Analysis:**

- **First upland field:** This is a survey field in Gwengabara, it was ploughed 3 times and then planted. The variety planted here is NAMCHE -1 which is just recently been released by NaCRRI. It is ready for weeding and am waiting for AEATREC to come to do it. They are coming this week.

- **Second upland field:** This is a survey field in Akia, it was ploughed once after applying a non selective herbicide and then planted. The variety planted here is NAMCHE -1 also and we have completed hand weeding on Saturday 28th September 2014. All the activities in this field is being carried out without the help from AEATREC.

4. **Challenges: Breakdown of some parts of the PT.**

- **Failure of the clutch:** this happened when the AEATREC staff was the one operating the PT and Nishikawa was still around. **PT** was taken back to FEIL for repair and it was brought back when the accelerator cable was stack and could not be pull, to accelerate the engine.

- **Accelerator cable:** After some times FEIL sent their engineer who replaced another accelerator system. It worked for some times and later got broken again on the 1 September 2014. I reported to both FEIL and 3WM while I was trying to look for a similar cable that can fit it from within Lira town. 3WM gave some money to FEIL engineer who bought one and sent it to Lira, but unfortunately it did not fit since its diameter was too large to enter into the cables pipe. This forces me to modify the cable for the bicycle brake and it is still working up to now.

- **Leakages:** After the PT was brought back from FEIL, the left hand herb and the behind of the gear box is leaking and at the same time the V belt was replaced by the used one.

- **Other challenges:** The onset of this survey coincided with the death of my farther and a health problem that I suffered. The above problems affected me as a person seriously and have resulted in to poor mobilization of my resources to effect the survey very well.

5. **Interested people who want to purchase PT:** There are people and organizations who wants to buy PT for their use. These are: FAO Lira wanted 5 units, Rice breeder from NaCRRI wanted one unites, Mr. James Otim wanted one unite, Dr. Oweta Jacob wanted one unite, Mr. Alelr Fred wanted one unite. These are the people who want it as soon as possible and I have directed them to 3WM. Besides these people there are also other people and organizations who wants though not very soon.

Conclusively, this survey is still proceeding well and I belief the data being collected will be most representative enough to give information on Japanese power tiller operation and utilization as labor saving technology appropriate for this region.

Photo 1: 2nd plowing of 1st upland field (experimental field in gweng-abara) (1)

Photo 2: 2nd plowing of 1st upland field (experimental field in gweng-abara) (2)

Photo 3: PT hire service being given to Ireda P.7 school.

Photo 4: A staff from 3WM trying to repair accelerator cable after delivering PT.

Photo 5: Planting second upland field in Akia without the help of AEATREC staffs (1)

Photo 5: Planting second upland field in Akia without the help of AEATREC staffs (2)

Report of Demonstration of Agricultural Machinery for Agricultural Trade Show in Lira

Okullo Paul Peter

Introduction

Lira district Local government through the office of the District Agricultural Officer DAO, every year organizes Agricultural trade show to celebrate World Food Day. The main objective of this show is to give opportunities to all the stakeholders along the agricultural value chain to exhibit, shear and promote their technologies and services with the users. It always takes place at district Agricultural show ground about one kilometer along Lira-Kotido road.

For the year 2014, the DAO Lira invited me to take the PT and it assorted implements for the exhibition at my own cost, and the detail of its report is as below:

The equipments that were taken for exhibition were as follows:

- Power Tiller.
- Tailor.
- 2 Mouldboard plough (Indonesia and Namalere).
- Double Disk plough.
- Planter.
- Weeder.

The people who conducted the exhibition were:

1. Okullo Paul Peter
2. Mr. Okec Job (Operator)
3. Mr. Opio Jasper (Assistant Operator)
4. Alele Fred (my business partner who was also trained on who to operate PT).
5. We were later join by JAICAF (Takahata and Yoshida) and AETRECT (Eng. Saasa)

Methodology

- **Display of equipments**: All the equipments were displayed at the stale given to us and the participants could come to view and we explain its functions and operation of each.
- **Demonstration of each operation:** There were also practical operations of each equipment to the participants at some particular instances.
- **Presentation:** There was details presentation of the entire technologies to especially to the guest of honour and invited dignitaries.

Participants:

The participants came from the entire Lango sub-region and the surrounding districts. The compositions were as below:

- Agricultural professional.
- Business community.
- Agro- processors.
- District officials and politicians.
- Traditional leaders
- Farmers.
- Security personals.
- Students

Impact of the exhibitions.

1. It exposed the comparative advantage of Japanese PT against other PT available within the district.
2. One participant (Mr. Obong Yoventino) from this trade show developed the interest to purchase PT and has already paid for it with 3WM.
3. Centenary Bank also develops interest in the PT as one of the best capital investment to their clients, and up to now the branch manager of Lira is still making the follow-up on how to acquire it.

Challenges:

1. The only challenge that we faced during this activity was only in the budget that was not planed earlier.

Conclusively: This exhibition is one of the very important events in the region that participating in it contributed so much in popularization of the Japanese PT technologies.

Photo 1: The bank manager centenary bank asking questions whether PT can be a capital investment for clients

Photo 2: Chairman chamber of commerce and others joint the bank manager during the discussion.

Photo 3: Lango paramount chief admire PT

Photo 4: PT is being demonstrated to the participant on the quality of its plough using the moldboard plough.

Photo 5: The same demonstration is being continued using disk plough.

Photo 6: JAICAF has joint us during the demonstration.

Photo 7: Mr. Okullo Paul Peter is making presentation about PT technology to the guest of honor and participants

Photo 8: One of the business partner posses for a photo with Takahata, Mariko, Peter, Okec and a district official.

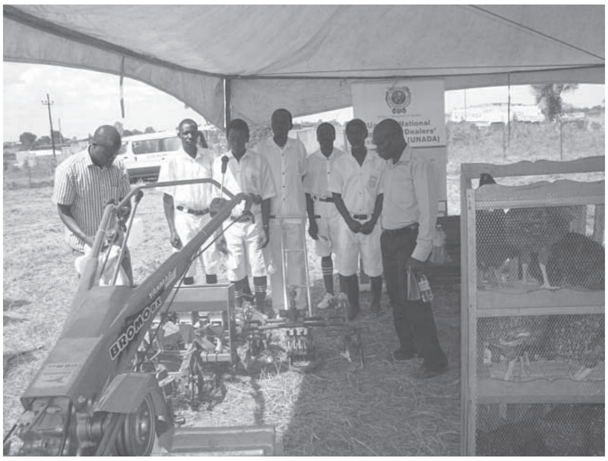


Photo 9: One of the farmer's group members being explained the PT technology during the demonstration.

Photo 10: Mr. Peter distributing the leaf let to the participant after the presentation.

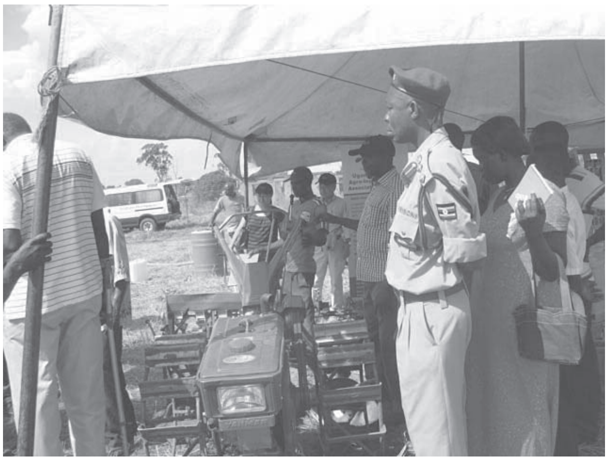


Photo 11: Staffs from a prison farm near the trade show ground also expressing their interest in Japanese PT.

Photo 12: Students asking questions about the PT technology

Photo 14: One of the prominent business man in Lira asking questions about the Japanese PT.

Photo 15: Mr. Obong (a aman looking back) developed an interest from this show and paid for PT to 3WM.

Report of Demonstration in Lira area

Okullo Paul Peter

Introduction.

Japan Association for International Collaboration of Agriculture and Forestry (JAICAF) is conducting a feasibility survey on the suitability of mechanization with smallholder farmers in Uganda funded by Ministry of Agriculture, Forestry and Fisheries of Japan since 2013. In Uganda, Lira district is identified as one of the survey area and activities of the survey being carried out are; Demonstration of Japanese power tiller BROMO DX) with its assorted implements to the farming communities of Lira areas, secondly is the Practical agricultural production of PT on survey field and hire service, and Lastly is the baseline survey of farming situation in Lira district.

This report is therefore on the second demonstration that took place in December 2014 in the three locations of Adwari sub-county in Otuke district, Abia sub-county in Alebtong district and Amach sub-county in Lira district.

The main objective of this exercise is to promote and popularize Japanese PT and their associated implements

The main activities carried out during the demonstrations were as below:

1. Mobilization with districts and sub-counties leaders.
2. Radio talk show.
3. Demonstration of PT operations with its assorted implements to the farmers.

ACTIVITIES

Mobilization at districts and sub-counties leaders:

Since Lira district is currently divided into smaller district by the central government for easy service delivery, the areas identified for the demonstration were located in three different districts that were divided from the former main Lira district. And they are; Otuke district, Alebtong districts and Lira district. The above areas were selected because they best fulfill the criteria set for the demonstration site.

The mobilizations were done twice, both at district level and sub-county level. The first one was done by Mr. Okullo Paul Peter, and during this time he met with the DAOs of the above districts individually at their district, and introduced the background of the survey and all its activities and how the project had identified their district and later discussed generally what is expected of them, and drew up the conclusion on how best to implement the activities. Then together with the DAOs we identified the best sub-county that would best suit the demonstration. I was then directed to the sub-county identified, and the same process that was done at district level, was again done at the sub-county level were we ended up with the identification of a parish, village and the farmers field where the demonstration would take place. The details are in the table below:

The table showing the details of the identified District, Sub-county, Village and the farmer's field identified for demontration.

No	District	Sub-county	Parish	Village	Farmer's field
1	Otuke	Adwari	Agoba	Olarokwon	Odur Peter
2	Alebtong	Abia	Abia	Abia central	Oluk Jogo
3	Lira	Amach	Ayito	Conner amach	Olwol Ben

The second mobilization was done mainly to confirm and approved the suitability of the above locations and to continue with the mobilization for the best results. It was done together by the team from JAICAF (Takahata and Yoshida Mariko), AEATREC (Eng. Saasa) and Mr. Okullo Paul Peter from Rural Livelihood Promotion Initiative (RLPI) who is coordinating the activities from Lira side. During this activity, the team managed to relocate from one field in Abia sub-county to another field with in the same area because of its accessibility. But all in all the above mobilization activity ended up with the list on the table.

Radio Talk show

This was intended to throw more light to the entire community about the all program of JAICAF, Japanese PT and the coming demonstrations through radio and it was a one hour talk-show aired life in "Voice Of Lango FM" radio station located at Obote Avenue in Lira town.

The presenters were:

1. **Mr. Okullo Paul Peter, Coordinator RLPI**: Who gave the back ground of the entire program and the activities involve. Also presented the details about the Japanese PT, its comparative advantages with other technologies and what farm activities it can do.
2. **Ojok Tony, DAO Otuke District**: Emphercise on the need to transform agricultural production through embracing the new technologies like the Japanese PT and later announced the date, time and location of the demonstration and later in his capacity as a DAO called the people of Otuke to come and participate in the demonstration.
3. **Oyuru Jenifer, DAO Alebtong District:** Emphercise the same thing for the people of Alebtong.
4. **Alum Dorcus, DAO Lira:** Also emphercise the same thing for the people of Lira.

At the end of the talk show, the telephone line was open for the listeners to asked the questions about what they have had, and the questions asked were as follows:

1. **James, from Alito sub-county in Kole district**: what will be the price of the PT?
2. **Nelson Ouni from Oyam district**: Can the farmers group be allow purchasing in a group?
3. **Jasper:** Who will provide the service and mechanical repair?
4. **Bosco:** The price should be lower since the farmers' incomes are low.
5. **Patrick from Alebtong**: The location of demonstration is far away from his sub-county and should be revised.
6. **James from Amolatar district**: They also wanted the demonstration in their district.
7. **Denis from Abia sub-county**: should be provided to farmers on credit.
8. **Acuma Isaac from Otuke**: Who will train the people who will buy on how to operate.
9. **Moses Odongo from Aromo sub-county**: The entire demonstration sites are very far away with them, why don't they be considered with another demonstration site.
10. **Partrick from Amach sub-county**: Farmers should be given opportunity to buy in loans.
11. **Owera Sam**: Government should help farmers to pay some percentage.

All these questions were answered accordingly, for instance the question about price, I answered that it would start from 16 million to 24 million depending on other equipments one would like to buy with the PT. And lastly, at the end of the show we gave our telephone number to the listeners. As such we continue to receive calls from some farmers pertaining demonstrations and the PT.

DEMONSTRATION OF PT OPERATIONS WITH ITS ASSORTED IMPLEMENTS TO THE FARMERS.

The above demonstrations were scheduled as below:

No	Date	District	Sub-county	Village	No. of Participants
1	4/12/2014	Otuke	Adwari	Olarokwon	145
2	6/12/2014	Alebtong	Abia	Abia central	410
3	6/12/2014	Lira	Amach	Conner Amach	523
	Total				**1,078**

Note: The numbers of participants were counted by each DAO of respective district during the demonstration, and according to them, participants were coming in shift for the demonstration. for instance in the mid-morning, day and afternoon. In Lira and Alebtong districts the demonstration were conducted during the market day and near the market, that is why we manage to get such a good numbers of participants.

The equipments that were demonstrated were as follows:

- PT.
- Mold board plough.
- Disk plough
- Planter
- Weeder
- Reaper
- Thresher
- Water pump
- Maize Sheller
- Trailer.

The Team who conducted the demonstration were from:

1. JAICAF
2. AETREC
3. 3WM
4. DAOs
5. Mr. Peter and PT Operators.
6. JICA Kampala and JICA Gulu also attended.
7. Others (Radio and News paper Journalist).

Methodology

- **Verbal explanations of each equipment**: Before practical demonstration, each equipment is displayed to the participants, and they are sensitized about its functions, advantages and other good attributes about it.
- **Practical demonstrations of each operation,** Here we demonstrate the operations of each machine and invite some farmers to come and operate the equipment being demonstrated by themselves.
- **Questions and answers,** at the end of the events participants are allowed to ask questions and clarification on any issues they have not got properly. And the common questions being asked were as below:
    1. What is the fuel consumptions of the PT?
    2. Where can it be bought from?
    3. What is the price per unit?
    4. Where can the spare parts are got from?
    5. Can it be bought through the loan system?
    6. Who will do the maintenance service and repair?
    7. Can it be bought by installments?

IMPACT OF DEMONSTRATION:

- The major impact of the above demonstration is that it made farmers to realized that there are technologies that are easy to operate, maintain, are durable and can certify their conditions appropriately.
- It also differentiates between the Japanese PT and Chinese PT that this country has experienced as worthless for some times.
- It made many farmers and other NGOs like FAO, Sasakawa Uganda and World Vision international to see Japanese PT as a technology to increase farmer's production and productivities, and as such they have adopted it as a strategy to achieve their project objectives
- It motivated many people to make plan of buying PT.

Conclusively, the above demonstrations have created a lot of positive impact both to the farmers, dealer and other stakeholders.

Photo 1: Mr. Okullo Paul Peter and the three DAOs during the Radio talk show at Voice of Lango in Lira town

Photo 2: Staffs from AEATREC taking reaper to the demonstration site in Otuke district

Photo 3: Mr. Peter is giving Verbal explanations about Japanese PT technology to Participants during a demonstration in Otuke.

Photo 4: Takahata is continuing with the explanation of the Japanese PT to the participants.

Photo 5: Takahata answering questions asked by the participants and is being translated by Mr. Ojok Tony the DAO of Otuke district.

Photo 6: One of the participants is operating the PT to plough during the demonstration in Alebtong district

Photo 7: Participants admire efficiency and the good quality that Yanmar rice thrasher is producing during a demonstration in Alebtong district.

Photo 8: Eng. Saasa of AEATREC demonstrating how a PT can be attach with a maize Sheller to shell maize to participant during a demonstration in Alebtong district.

Photo 9: One of the farmers leaders giving his observation on the PT technology during demonstration in Abia sub-county Alebtong district.

Photo 10: Mr. Okec is demonstrating a PT with a trailer attach to it as a means of transport in Abia sub-county Alebtong district.

Photo 11: A female participant operating a reaper to harvest rice during the demonstration in Amach sub-county in Lira district.

Photo 12: This is a demonstration of maize shelling using PT in Amach sub-county Lira district.

List of Authors

Matsumoto Iwao	Technical Advisor Japan Association for International Collaboration of Agriculture and Forestry, JAICAF
Nishikawa Nanami	Consultant Vision and Spirit for Overseas Cooperation Co,Ltd.
Nishimaki Ryuzo	President, JAICAF
Nishino Shunichiro	Researcher, JAICAF
Oizumi Nobuaki	Expert for Rice Cultivation Technology The Project for Supporting Rice Industry Development, TANRICE-2, JICA
Takahata Tsuneo	Technical Advisor, JAICAF
Tanaka Mari	Researcher, JAICAF
Tokida Kunihiro	Senior Advisor, JICA Ex-Chief Advisor / Agricultural Mechanization Expert for Rice Promotion Project, Uganda