Ministry of Agriculture
United Republic of Tanzania

Data Collection Survey on Strengthening of Training System and Promoting Rice Cultivation Package in the United Republic of Tanzania

Final Report

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Resource: Political Map of Tanzania, based on a UN map

Tanzania Location Map

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Abbreviations

AFICAT	Africa Field Innovation Center for Agricultural Technology
ASA	Agricultural Seed Agency
ASDP	Agricultural Sector Development Programme
ATC	Arusha Technical College
CARD	Coalition for African Rice Development
CARI	Competitive African Rice Initiative
CRDB	Cooperative and Rural Development Bank
CS	Certified Seed
DADP	District Agriculture Development Plan
DAICO	District Agricultural, Irrigation and Cooperative Officer
DG	Director General
DSA	Daily Subsistence Allowance
DSM	Digital Surface Model
DTR	Agricultural Training and Research Division
FFS	Farmers Field School
GIS	Geographic Information System
GSD	Ground Sampling Distance
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HST	Hydro-Static Transmission
ICT	Information and Communication Technology
IS	Irrigation Scheme
ISM	Irrigation Scheme Management
JICA	Japan International Cooperation Agency
JIRCAS	Japan International Research Center for Agricultural Sciences
KATC	Kilimanjaro Agricultural Training Centre
MATI	Ministry of Agriculture Training Institute
MoA	Ministry of Agriculture
NERICA	New Rice for Africa
NGO(s)	Non-Governmental Organization(s)
NIRC	National Irrigation Commission
NRDS-II	National Rice Development Strategy Phase II
O&M	Operation and Maintenance
OJT	On-the-Job Training
PHRD	Policy and Human Resources Development Fund
QDS	Quality Declared Seed
RPAS	Remotely Piloted Aircraft Systems
SACCO	Savings and Credit Cooperatives Organization

SHEP	Smallholder Horticulture Empowerment & Promotion
SoA	School of Agriculture, State University of Zanzibar
SRI	System of Rice Intensification
SUA	Sokoine University of Agriculture
TADB	Tanzania Agricultural Development Bank
TANRICE 1	Technical Cooperation in Supporting Service Delivery Systems of Irrigated Agriculture
TANRICE 2	Project for Supporting Rice Industry Development in Tanzania
TANRICE 2.5	Data Collection Survey on Strengthening of Training System and Promoting Rice Cultivation Package in the United Republic of Tanzania
TANRICE 3	Project for Strengthening Capacities of Stakeholders of Rice Industry Development
TARI	Tanzania Agricultural Research Institute
TCAA	Tanzania Civil Aviation Authority
TFNC	Tanzania Food Nutrition Center
TG	Task Group
TOSCI	Tanzania Official Seed Certification Institute
ToT	Training of Trainers
USAID	United States Agency for International Development
WFP	World Food Programme

1. Background and Objectives of the Survey

1-1. Background and Context of the Study

The agricultural sector in Tanzania is crucial, accounting for approximately 30% of GDP and 70% of employment. In particular, rice production accounts for approximately 17% of the total grain production, and the country has nearly achieved self-sufficiency in rice. However, the demand for rice is estimated to increase with population and economic growth, making rice production one of the most crucial policy issues.

The current "National Five-Year Development Plan (2021/22–2025/26)" being implemented in Tanzania aims to accelerate economic growth and promote sustainable development.

Based on the "National Five-Year Development Plan," the "Agricultural Sector Development Programme Phase II (ASDP II)" was implemented in the agricultural sector from 2017/18 to 2027/28. This program aims to promote market-oriented agricultural systems and improve agricultural production systems by considering demand trends for food, raw materials, and labor. In particular, it aims to achieve sustainable growth in the agricultural sector, establish market-oriented agricultural systems, improve agricultural policies, and enhance the livelihoods of agricultural practitioners (farmers). In the field of rice cultivation, the program sets objectives such as sustainable water management, improving rice production, improving variety, technical support for agricultural practitioners (farmers), improving storage, processing, and distribution, and expanding agricultural finance.

The "National Rice Development Strategy Phase II (NRDS-II)" was implemented in the field of rice production from 2017/18 to 2027/28. This strategy aims to improve rice yields, increase the income of farmers, and ensure food security. Specific objectives include improving rice productivity, promoting and disseminating rice cultivation technologies suitable for the market, and developing water management facilities. The primary goals of this strategy are as follows:

1. Improve rice productivity: Enhance rice productivity by introducing high-yielding rice varieties and agricultural machinery and improving water management and soil.
2. Improve the living standards of farmers: Increase the income of farmers and improve their living standards.
3. Promote exports: Promote rice exports and increase foreign currency by improving productivity.
4. Environmental protection: Promote environmental protection through soil conservation and water resource management.

Furthermore, the specific activities are as follows:

1. Disseminate high-yielding rice varieties: Introduce and promote high-yielding rice varieties suitable for various conditions in Tanzania.
2. Improve water resource management: Ensure a stable water supply by improving irrigation systems and strengthening water resource management.
3. Promote agricultural machinery: Increase productivity through the introduction, improvement, and support of agricultural machinery for maintenance and repair.
4. Promote soil improvement: Encourage using organic and microbial fertilizers to promote soil health.
5. Enhance the technical capacity of farmers: Improve their technical skills by providing training and technical guidance.

6. Establish an agricultural insurance system: Develop an agricultural insurance system to compensate for crop damage caused by disasters and diseases.

Through these policies and initiatives, Tanzania is advancing the modernization and commercialization of the agricultural sector, strengthening food security. However, food and nutritional deficiencies remain a challenge. Therefore, continuing to implement policies that drive future technological development and dissemination is imperative.

Japan has an extensive history and experience in providing cooperation and support for Tanzania to become a leading rice-producing country in Africa, starting with rice production cooperation in the 1970s and making full use of a comprehensive scheme of grant aid and technical cooperation.

1970s	(Development Study/Technical Cooperation) Integrated Development Study for the Kilimanjaro Region
1981	(Grant Aid) Construction of a Kilimanjaro Agricultural Development Centre (KADC)
1978–86	(Technical Cooperation) Kilimanjaro Agricultural Development Centre (KADC) Project
1987	(Loan Assistance) Lower-Moshi agricultural development project
1986–93	(Technical Cooperation) Kilimanjaro Agricultural Development Project
1994–2001	(Technical Cooperation) Kilimanjaro Agricultural Training Centre (KATC) Project
2001–06	(Technical Cooperation) Kilimanjaro Agricultural Training Centre (KATC) Phase II Project
2007–12	(Technical Cooperation) Technical Cooperation in Supporting Service Delivery Systems of Irrigated Agriculture (TANRICE)
2013–19	(Technical Cooperation) Project for Supporting Rice Industry Development in Tanzania (TANRICE 2)
(Planned) 2023–	(Technical Cooperation) Project for Strengthening Capacities of Stakeholders of Rice Industry Development (TANRICE 3)

The project initially focused on the construction and maintenance of the Lower Moshi Irrigation Scheme and the development of water-use associations as part of agricultural development in the Kilimanjaro Region. The technology transfer methods developed in this area have been applied since 2000 to the KATC Phase 2 project and TANRICE 1 and 2, primarily through extension training at KATC and Ministry of Agriculture Training Institutes (MATIs), with a focus on promoting irrigated rice cultivation.

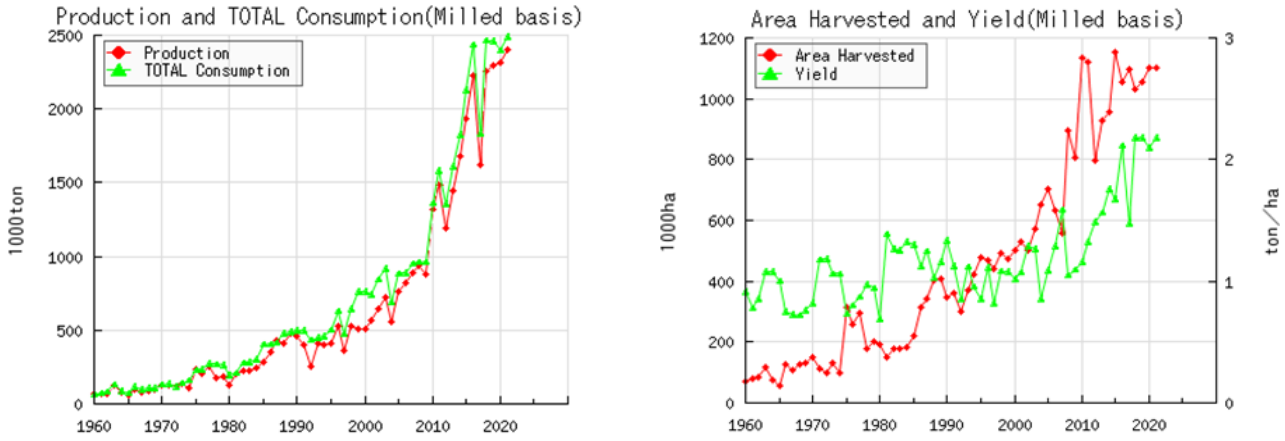


Figure 1. Rice Production in Tanzania ("World Food Statistics" by Shoichi Ito, PhD)

However, the Tanzanian government has not yet implemented rice production technology training solely and sustainably through its budget. There is a need for KATC and MATIs to take measures to continue the training packages themselves. To meet the increasing demand for rice in limited irrigated rice production areas, TANRICE 3 is expected to improve training and extension systems for irrigated rice cultivation technology. However, the project encountered major issues, such as (a) establishing rice cultivation technology for rainfed rice cultivation, (b) increasing the production of qualified seeds, and (c) promoting the use of agricultural machinery. In addition, there is a need to improve training on (d) marketing, gender, and irrigation scheme operations and management.

Considering these issues, this survey will be conducted before the implementation of TANRICE 3. The survey plans to conduct trial training, and the findings and lessons learned from the training will be used to ensure that TANRICE 3 is implemented smoothly.

1-2. Survey Objectives

The objective of this survey was to contribute to the smooth and effective implementation of TANRICE 3 by conducting the following activities and collecting necessary information:

(1) Establish a comprehensive training system based on an understanding of the current situation.

(2) Strengthen the self-reliance and sustainability of the rice cultivation training system.

(3) Establish an efficient cultivation system and increase production by improving rice cultivation techniques (particularly rainfed rice cultivation)

(4) Strengthen rice cultivation primarily in the East African region by sharing knowledge with neighboring countries.

(5) Study the direction of assistance provided by the Japan International Cooperation Agency (JICA) in the rice cultivation sector

1-3. Survey Target Area

All areas of Tanzania (narrowed based on survey policy and content).

1-4. Cooperating Organizations

Ministry of Agriculture, Ministry of Agriculture Training Institutes (MATIs, KATC), School of Agriculture (SoA), and the State University of Zanzibar.

2. Overview and Issues in Rice Cultivation and Agricultural Machinery

According to the National Rice Development Strategy Phase II (NRDS-II) (2019), the area under different types of cultivation (irrigated rice, Rainfed lowland rice, and Rainfed upland rice in Tanzania is 9%, 71%, and 20% of the total area under cultivation respectively. In order to stably increase rice production in the future, it is considered important to increase the production of rice under rainfed condition such as low and unstable rainfall conditions, which account for the majority of the area.

The following describes the current situation and issues of irrigated and Rainfed rice cultivation, mainly based on the information collected during the survey.

2-1. Irrigated Rice Cultivation

2-1-1. Current situation of Irrigated Rice Cultivation

< Surveyed areas >

◆ Irrigated rice cultivation area (Irrigation Scheme, IS) (1)

- Survey Period: February 2022
- Venue: Lower Moshi Irrigation Scheme (IS), Moshi District, Kilimanjaro Region
- Current situation: In the IS, rice cultivated rice three times a year (December to June, May to September, and August to December), but in reality is that the two cropping seasons are adjusted in consideration of labor, irrigation water, field conditions, and other factors. The rice varieties cultivated in this scheme are mostly SARO5 and IR64, with IR64 being a slightly earlier maturing variety than SARO5. The cultivation was well managed in terms of weeding and water management. According to a nearby rice mill, the selling price was the same for both varieties.

◆ Irrigated rice cultivation area (IS) (2)

- Survey Period: July 2022
- Venue: Bagamoyo Irrigation Scheme (IS), Bagamoyo District, Pwani Region
- Current Situation: A total of six people, including the scheme manager, the cooperative head and other farmers (four people), were gathered and interviewed through the English-speaking scheme manager with extension officers. The following information was obtained through the interviews.
  - Number of farmers: 120 (50 men and 70 women)
  - Cultivated area: 72 ha
  - Variety: SARO5 (TXD306)
  - Seed: Seed purchased from ASA, TARI, SUA, etc.
  - Cropping calendar: 1st season: plowing (May) - harvest (September), 2nd season: plowing (October) - harvest (February)
  - Cultivation method: Plowing (farmer-owned power tiller outside IS borrowed),
  - Transplanting (regular row planting by hired labor)
  - Fertilization (one application as basal dressing and two additional applications as topdressing)
  - Harvesting (harvesting with a combine harvester owned by a farmer outside the IS, as well as with a

power tiller)

- Yield: average 5.0 t/ha (rainy season crop), 3.5 t/ha (dry season crop)
- Reasons cultivating SARO5 (TXD306) included
  1） High yield
  2） Good taste
  3） Resistance to pests and diseases
- The main challenges identified were
  1） Old irrigation pumps and fuel costs
  2） High prices of agricultural materials (fertilizers, seeds, etc.)
  3） Bird damage
  4） Flooding (March-May)
  5） Marketing (unable to wait to sell until higher prices, need cash)
  6） Salt damage
  7） Rehabilitation of irrigation canals

◆ Irrigated rice cultivation area (IS) (3)

➢ Survey period: March 2022

➢ Venue: Bumbwisudi Irrigation Scheme, West District, Mjini Magharibi, Zanzibar

➢ Current Situation: There are currently 20 farmer leaders in the cooperative, and one leader and four or five farmers form one team to propagate the cultivation technology; technology dissemination from about 100 farmers in 20 teams to other cooperative members is developed on a Farmer-to-Farmer basis. For this interview, four farmer leaders and one agricultural extension officer gave the following information on the current status of rice cultivation.

- Number of farmers: 1,022
- Cultivated area: 210 ha
- Variety: improved Supa B/C 130 days, TXD88 (Nanenane, Kikwete) 130 days, SARO5 (TXD306) 130 days
- Seed: some farmers produce SARO5, TXD88 under the guidance of the Ministry of Agriculture. It is sold as seed at a pricet of 2,000-2,500 TZS/kg.
- Cropping calendar: heavy (main) rainy season crop (plowing and land preparation January and February, harvest June and July), short rainy season crop (plowing and land preparation: August and September, harvest: December and January).
- Cultivation methods:
  1) Plowing (the cooperative does not own tractors or power tillers, so plowing is done with privately owned machinery or with government services for a fee)
  2) Transplanting (regular row planting: spacing of 15 x 25 cm and 15 x 30 cm for transplanting was learned in training, but now many farmers transplant at 10 x 30 cm. Seedlings are raised in part of the field and 15-21 days old seedlings are used. The seeds are selected in salt water before sowing.

3) Fertilization (first application of 13 kg/plot (1,000 m2) of DAP at rice planting, second application of 16 kg/plot of urea 14 days later and third application of 16 kg/plot of urea 42 days later).

4) Weeding (herbicides and hand weeding are common; for push weeder, wooden was relatively good but iron was too heavy to use. Neither is used today).

5) Harvesting (the company owns two reapers and two threshing machines provided by the Ministry of Agriculture and operated by four operators. Reaping fee 30,000 TZS/plot)

- Irrigation water: There are 15 wells in the irrigation zone and groundwater is used. All are pumped by electric pumps and electricity costs 300 TZS per unit, with an average of 5 units used per hour of irrigation).
- Yield: Average paddy yield 700 kg/plot/period
- Selling price: 50,000-60,000 TZS/50 kg
- TANRICE results: All participants unanimously stated that there was an increase in revenue. Specific results were as follows: in the case of Mr A, the revenue increased from 350 kg/plot to 800 kg/plot; Mr B increased from 250 kg/plot to 600 kg/plot; Mr C increased from 250-300 kg/plot to 700 kg/plot; and Mr D increased from 200-250 kg/plot to 600 kg/plot. Mr D increased his revenue from 200-250kg/plot to 600kg/plot.
- Challenges:

1) Irrigation costs (high cost of electricity because of soil channels and high leakage when the distance between the water source and the field is far from the source). Basically, the irrigation canal is used for supplementary irrigation during heavy rainy season crops. Some farmers do not grow rice in short rainy season crop and grow vegetables. Electricity costs in one cropping season range from 20,000 to 60,000 TZS/plot).

2) Fertilizer costs (DAP = 120,000 TZS/50 kg, urea = 115,000 TZS/50 kg, which has risen. Sometimes difficult to obtain in a timely manner).

3) Storage and sales (the cooperative does not own a grain warehouse, so basically sales are done privately).

4) Agricultural machinery for plowing (the cooperative does not own agricultural machinery for land preparation such as plowing and therefore cannot conduct plowing in a timely manner).

◆ Irrigated rice cultivation area (IS) (4)

➢ Survey Period: March 2022

➢ Venue: Cheju Irrigation Scheme, Central District, Kusini Unguja Region ,Zanzibar

➢ Current Situation: During the visit, it was the busy farming season of the heavy rainy season, and the survey team interviewed three farmer leaders while asking them to stop their work at the site.

➢ Farmer leader A (TANRICE training in 2014)

There are 20 farmer leaders in this irrigation area, and each leader covers 40 plots for dissemination. We expect Farmer to Farmer extension approach method to spread techniques from them.

- Variety: SARO5, Bagamoyo (cultivation period: 120 days)

- Seeds: seeds were purchased in 2014 and have been self collected since then (seeds are selected and harvested by hand before harvesting all together with a combine harvester)
- Cultivation methods:
  1） Plowing (basically plowed for a wage. Plowing fee: 7,500 TZS/plot for tractor (government-owned), 15,000 TZS/plot for management equipment (for plowing)
  2） Transplanting (13 x 30 cm in regular row plantings, 2 or 3 seedlings previously 4 or 5 seedlings), Seedling age: 9- to 14 days after sowing)
  3） Weeding (herbicide and hand weeding; push weeder has not been repaired since it broke down)
  4） Harvesting (using combine harvesters, one privately owned and one cooperative owned in the community Harvesting fee: 30,000 TZS/plot (120,000 TZS/acre)
- Yield: 500-550 kg/plot/period
- Selling price (paddy price): 50,000TZS/50kg; milled rice price: 1,700-2,000TZS/kg
- Water use charge (electricity): 30,000 TZS/plot for heavy rainy season crop, 35,000-40,000 TZS/plot for short rainy season crop
- TANRICE results: specifically, paddy yield increased from 350-400 kg/plot/period to 500-550 kg/plot/period.

➢ Farmer leader B (attended TANRICE training in 2014)

One farmer leader transfers technology to roughly 5 farmers.

- Variety: SupaB/C, SARO5
- Seed: SARO5 initially purchased. After that, they select seeds in the field and self collection.
- Cultivation method
  1） Plowing (rent Plowing)
  2） Transplanting (regular row planting)
  3） Weeding (herbicide and hand weeding; wooden push weeder was easy to use, but iron weeder was heavy and difficult to use)
  4） Harvesting (using combine harvester)
- Yield: (600-650 kg/plot/period, previously 350-450 kg/plot/period)
- Irrigation water: There are 6 wells in the irrigated area, all pumped by electric pumps.
- Challenge: Improvement of conventional pump irrigation system using groundwater and fertilizer application technology based on soil diagnosis

➢ Farmer leader Mr. C (attended TANRICE training in 2014)

Provided technical guidance to 37 neighboring farmers.

- Varieties: SupaB/C, Subangi, SARO5, Bagamoyo (70% of cultivated area)
- Seeds: Self collection
- Cultivation method
  1） Plowing (plowing for rent: one government-owned tractor, one privately owned tractor, and two are available in the community)
  2） Transplanting (regular row planting)

3） Weeding (herbicides and hand weeding; the wooden, push weeder with nails was the easiest to use, but has not been repaired since it was broken)

4） Fertilization (expensive and not available in a timely manner)

5） Harvesting (using combine harvesters): two available, one government owned and one privately owned. Harvesting fee: 30,000 TZS/plot

- Yield: (600 kg/plot/period, previously 400 kg/plot/period)

◆ Irrigated rice cultivation area (IS) (5)

➢ Survey Period: March 2022

➢ Venue: Mtwango IS, West District, Mjini Magharibi Region, Zanzibar

➢ Current Situation: The current situation in this irrigation area was interviewed from three people: the cooperative chairman and farmer leader, the cooperative secretary, and an intermediate farmer. The cooperative leaders' work is basically water management, agricultural guidance, and mediation of disputes.

- Number of members: 837
- Cultivated area: 83 ha
- Variety: improved varieties (SARO5, Supa B/C, TXD88, cultivation period: 120 days), local varieties (Supa India, Bawa mbili, Suban, Kalamata, cultivation period: 120 days + 20,30 days)
- Seed production: purchased only at the beginning and self collected since then.
- Cropping calendar: two cropping seasons: heavy rainy season (plowing and land preparation in March, harvest in August) and short rainy season (plowing and land preparation in September, harvest in February)
- Cultivation methods:

1） Plowing (plowing by hand using a hoe and individually owned plowing equipment. Plowing fee: 20,000 TZS/plot

2） Transplanting (planting in regular row plantings: seedlings are raised in a part of the field, and 2 or 3 seedlings are transplanted at 21 days of age after sowing)

3） Fertilization (13 kg/plot of TSP or DAP is applied at transplanting, 18 kg/plot of urea is applied 14 days after transplanting, and 8 kg/plot of urea is applied 44 days later)

4） Weeding (Weeding was conducted between rows by using a push weeder before the next fertilizer application (14 days after transplanting). (A rotary push weeder is difficult to use. (A wooden push weeder with a nail driven into a board at the end is easier to use.)

5） Harvesting and threshing: Basically, harvesting was conducted by hand, but since last year, two reapers and two threshers have been used. Operators were selected from the youth group. When harvesting by hand, it took one plot of three people about four hours to harvest, but when reapers are used, harvesting is completed in about 10 minutes per plot. Threshing one plot of rice by hand took three people about five hours, but with the thresher, one plot of rice can be threshed in about 30 minutes. The paddy is spread on a sheet and dried.

- Irrigation water:

1） Water source: Water is taken from the river and led to the fields by gravity, and groundwater is pumped up from two wells by an electric pump as a supplement.

2） Water Fee: 2,000 TZS/plot for heavy rainy season crop (June-August), 2,000 TZS/plot for short rainy season crop (December-January); supplemental irrigation by using groundwater is required in case of low rainfall. 50,000 TZS/period

- TANRICE Results: TANRICE training was conducted in 2010. The most significant result of the training was an increase in yield, from 300 kg/plot until 2010, which doubled to 600 kg/plot after the training. Possible reasons for the increased yield are seedling raising techniques, proper timing of transplanting (using young seedlings), regular row planting and using quality seeds.
- Marketing: No warehouse for harvested rice (paddy). Rice is sold on an individual basis. There is one privately owned rice milling machine (SB10) in the irrigated area, so it is possible to sell the rice as milled rice. Fee for rice milling: 70 TZS/kg/paddy weight. If rice bran is required, it must be purchased at 5,000 TZS/50 kg.

2-1-2. Challenges of Irrigated Rice Cultivation

1. Maintenance of irrigation facilities

ince a certain yield is generally obtained, it is essential to continue and accurately rehabilitate the irrigation pumps and facilities from the viewpoint of maintaining them first. For this purpose, it would be necessary to collect and accumulate appropriate water fees, etc. from farmers (members) as much as possible.

2. Training of irrigation technicians

It is important to develop human resources with the skills to operate and manage irrigation facilities, as well as to maintain and manage the facilities properly and accurately.

3. Introduction of agricultural machinery

It is necessary to introduce various types of agricultural machinery for efficient and timely operation. In addition to tractors, power tillers, and other field management equipment are necessary. Combine harvesters should be introduced to enable timely harvesting and to prevent losses during manual harvesting and post harvesting operations.

4. Introduction of other varieties

There are some observed where cultivation of the same variety during the growing season is divided into several groups in order to avoid overlapping operations. On the other hand, introducing other varieties (with different characteristics and properties, such as growing period) can enable it easily to avoid overlapping of operation periods and may allow selection of more suitable varieties for different cropping seasons (rainy and dry seasons).

2-2. Rainfed Rice Cultivation

2-2-1. Current situation of Rainfed Rice Cultivation

<Survey areas>

◆ Rainfed rice cultivation area (1)

- Survey period: March 2022
- Venue: Babati District, Manyara Region; Bumbwi Sudi District (Zanzibar), Unguja Region; Kyela District, Mbeya Region (see details in (2) below)
- Current Situation: The rainy season started late from the end of last year (2021) to the beginning of this year (2022) , and in the Rainfed paddy fields, land preparation before sowing was just about to start. In Kyela District, extension officers were aware of the existence of farmers' groups, and they were given the opportunity to participate in training by TANRICE 2. Although encouraged, there seemed to be little spread of the technology from demonstration plots (set up and managed mainly by key and intermediate farmers) to display plots in the region. Some key farmers had even stopped setting up demonstration plots. Although the farmers were aware through the demonstration plots that they could increase their yield per unit by changing from broadcasting to dibbling and transplanting, and by applying fertilizer, they seemed to have difficulty in introducing and practicing the technologies that were costly and labor intensive for them to avoid the risks associated with unstable rainfall. However, the varieties are gradually changing from local varieties to SARO5 (TXD306). However, SARO5 can be expected to produce more than twice the yield of the local variety in the example of the exhibit plots if rainfall is good, but the big yield loss during drought, difficulties in marketing in the same area where local varieties are popular, and low prices reflecting these difficulties may be reasons why the improved variety such as SARO5 is having difficulty spreading.

◆ Rainfed Rice Cultivation Area (2)

- Survey date: March 2022
- Venue: Kyela District, Mbeya Region
- Current Situation: The study village was selected after reviewing the Rainfed rice cultivation area (village) where the TANRICE 2 training was conducted and the content of the Rainfed rice cultivation training. Four villages were selected as study sites: Tenende village, Mwaya District; Bwato village, Ndobo District; Isanga village, Bujonde District; and Bujera village, Ipinda District.

  In TANRICE 2, the key farmers took part in the training, and the technology was transferred to intermediate and general farmers through "farmer-to-farmer extension approach". Specifically, a key farmer and four intermediate farmers worked together in groups of five to build demonstration plots where intensive rice cultivation technology was introduced, and the general farmers gathered at these plots to conduct Farmers Field Schools (FFS) to disseminate the technology.

  In the four study villages, interviews were conducted with key farmers, intermediate farmers, farmer group leaders, extension officers, and general farmers who participated in the training. In the case of Tenende village, the demonstration of fertilization techniques (type, timing, and amount of chemical

fertilizers) using SARO5 showed that yields increased from 480-800 kg/acre without chemical fertilizers (conventional method) to 2,000 kg/acre with the appropriate use of chemical fertilizers (intensive cultivation method). The benefits are shared by other villages as they have experienced double to triple yield increases by adopting intensive rice cultivation techniques. As the key and intermediate farmers have demonstrated increased yields in their demonstration plots with intensive rice cultivation technology, some farmers are beginning to follow and introduce them, while others say that they cannot adopt all the improved techniques because intensive cultivation is labor-intensive and it is difficult to apply expensive chemical fertilizers as instructed. In addition, due to unstable yields caused by factors such as drought, unstable rainfall, and irregular weather, the number of participants in the FFS has decreased over the years, and some villages have stopped setting up demonstration plots. Although the survey was conducted in a limited number of villages over a short period of time, line (row) planting cultivation has not spread because it requires more labor, although many farmers understand its benefits. As for the construction of bunds and the introduction of leveling technology, although traditional bunds for collecting surface water have been constructed, bunds for leveling have not been constructed. The number of bunds between rice fields, which are built by hand, increases for maintaining the level under sloping terrain. This also increases the amount of labor required, and is not widely used.

The improved variety SARO5 has been widely used, but popularity the use of "Kilombero", "Faia dume", "Rangi mbili", and other local varieties is also in the area. The yield difference between varieties was 960-1,120 kg/acre for local varieties and 1,600-2,400 kg/acre for SARO5. However, SARO5 has fewer sellers than local varieties and the purchase price is relatively lower. The yield is lower under less irrigation water condition than local varieties and the seed are difficult to obtain. Then local varieties were cultivated for these reasons.

When asked about the usefulness of the TANRICE 2 training, many of them mentioned the salt water selection of rice seed before sowing and the fact that the amount of seed was drastically reduced from 48 kg/acre to less than 16 kg/acre by changing from the conventional method of broadcasting to dibbling. However, dibbling is labor-intensive, so they asked if there was any labor-saving technology, such as a simple seeding machine. Many also mentioned the effectiveness of study tour that enable them to see rice cultivation in other areas during

◆ Rainfed Rice Cultivation Area (3)

- Survey Period: July 2022
- Venue: Bagamoyo District, Pwani Region
- Current Situation: Since the time of the visit was just during the dry season and before field operation (plowing) in the area, we asked about 30 farmers to gather in front of the Ward office and conducted interviews through the extension staff. The following information was obtained through the interviews.
  - Number of farmers: 600
  - Cultivated area: 640 ha (varies depending on cropping season (rainfall))
  - Average cultivation area per farmer: 2 acres

- Varieties: Local varieties (more than 20 varieties)
- Seed: Harvested seed is divided into seed for next season and food (rarely sold for subsistence)
- Cropping calendar: Plowing (November), sowing (December to March), harvest (June to August)
- Cultivation method: Manually plowed, broadcasting, no fertilizer, hand weeding, manual harvesting
- Yield: Average 2.0 t/ha
- The following reasons were given for growing local varieties
  1) SARO5 requires more irrigation water as an irrigated variety than local varieties.
  2) Local varieties have long culms (taller plant) and can be grown even when rainfall is heavy and water levels are high.
  3) Local varieties are stickier than improved varieties and have a better taste.
- The main issues identified are as follows
  1) Yellowing of the rice plant (probably due to insufficient soil fertility and fertilizer application)
  2) Damage by birds (early in the ripening period)
  3) Animal damage
  4) Drought damage (lack of water)
  5) Insect damage
  6) Hard soil, requiring time-consuming field operation (machinery needs to be introduced)
  7) Lack of irrigation facilities and dependence on rainfall for irrigation water prevents proper water management.

◆ Rainfed Rice Cultivation Area (4)

➢ Survey date: November 2022

➢ Venue: Ihimbili Village, Magu District, Mwanza Region (farmer training implementation district)

➢ Current Situation:

- Number of farmers: 1,144
- Cultivated area: 200 ha
- Variety: Local varieties (3 main varieties), a few farmers grow improved varieties (SARO5, Supa)
- Cultivation method: More than 80% of farmers conduct transplanting (random planting). The rest conduct direct sowing (broadcasting).
- Cropping calendar: Plowing (October), sowing (October), harvesting (April-May)
- Yield: Average 3.2 t/ha
- Reasons for growing local varieties: Better taste than improved varieties.
- The main challenges identified were
  1) Weeds
  2) Diseases
  3) Bird damage
  4) Flooding

◆ Rainfed Rice Cultivation Area (5)

- Survey period: November 2022
- Venue: Mahiga Village, Kwimba District, Mwanza Region (farmer training area)
- Current Situation:
  - Number of farmers: 1,800 (male: 1,170)
  - Cultivated area: 900 ha
  - Average cultivation area per farmer: 2 acres
  - Variety: More than 9 main varieties, including improved varieties SARO5 and Supa
  - Seed: Self collection, a few farmers purchase seed of improved varieties (SARO5)
  - Harvested paddy: seed for next season, edible, for use as food, 70-80% for selling and purchasing maize
  - Cultivation method 1: direct sowing (broadcasting), very few farmers conduct transplanting (random planting)
  - Cropping calendar: Plowing (November), sowing (December-January), harvest (May-June)
  - Cultivation method 2: 90% or more Plowing by oxen, no fertilizer, hand weeding, manual harvesting
  - Yield: SARO5 (improved variety): average 3.7 t/ha, Sukari (local variety): 3 t/ha
  - Reasons for growing local varieties
    1) They have a better taste than improved varieties.
    2) Local varieties are stronger than improved varieties in times of water shortage (drought tolerance).
  - The main challenges identified were
    1) Drought damage (lack of water)
    2) Weeds
    3) Bird damage
    4) Disease
    5) Insufficient development of farm roads, etc.

2-2-2. Challenges in Rainfed Rice Cultivation

1. Trial introduction of various varieties

In Rainfed rice cultivation areas, where irrigation water is dependent on rainfall and river flooding, the timing of rainfall often varies from area (region) to area (region) and from cropping season to cropping season, with some areas remaining flooded for long periods of time while others suffer from drought due to early receding water. In Rainfed rice-cultivation areas, farmers often grow many local varieties to diversify risk. It is important to understand the characteristics of these varieties as much as possible, and to conduct experiment with diversified of varieties, including upland rice varieties, that have a clear historical background and various characteristics and features, in order to select the best variety for the region or area, as well as from a market (sales) perspective.

On the other hand, as discussed below, varieties cultivated in rainfed rice-cultivation areas have been used for many years by farmers who are familiar with the local environment, and this should be taken into

consideration when introducing new varieties.

2. Continuation of cultivation trials

Related to the above, TANRICE 2 has established "Verification Trial (Field Trial)" plots in Rainfed rice cultivation areas in Kilombero District of Morogoro Region, Kyela District of Mbeya Region, and Msalala District of Shinyanga Region, and collected data. The results have been presented as one of the training items. In addition to differences in the amount and pattern of rainfall, the characteristics and conditions of each region are also different, and it necessary to continuously collect and accumulate more data from more areas in order to develop region- and district-based cultivation guidelines for rainfed rice cultivation, which is highly diversified in the future.

3. Shifting from broadcasting to drilling (dibbling)

Most farmers in rainfed rice-cultivation areas are currently conducted sowing by broadcasting. It is difficult to properly leveling the field by human or animal power, and it cannot be ruled out that in low areas there is a possibility of poor germination due to waterlogging. On the other hand, weeding, which is the key operation to increasing yields, is mainly done by hand, but it is extremely difficult to remove weeds properly in the field where seed were broadcasted, resulting in low yields. Although it is recognized that fertilizer application can increase yields in demonstration plots, due to the rising price of fertilizers, proper weed control should be considered first and improved the method from the viewpoint of increasing yield. For this purpose, it is necessary to encourage farmers to experience the advantages of drilling (dibbling), which is far more efficient and effective than broadcasting, and to shift from broadcasting to drilling (dibbling) as the first step toward technological improvement.

4. Methods of technology dissemination

Above all, it is essential to set up demonstration plots and show them "on the spot" near farmers' fields so that farmers can actually see and feel the differences and advantages of this technology compared to conventional methods. However, considering that there are some farmers who stop managing demonstration plots and that there are situations where the technology presented (exhibited) in demonstration plots is not accepted by farmers, it is necessary to give sufficient consideration to the location and management method of the demonstration plots and the technology to be presented. For example, it is essential to narrow down the technology to be presented to farmers, and to incorporate extension officers more in term of field management of the technology. It is important to install the demonstration plots in the key farmer's or other farmer's field so that the farmer does not feel the difference in "environment" between his own field and the demonstration field, so that he can easily follow and introduce the technology.

5. Consideration and introduction of technology according to water usage conditions

The "Rainfed rice cultivation areas" may vary from areas where water cannot be controlled at all (e.g., flooded areas) to areas where minimal control is possible. This means that they range from areas that are as

close as possible to irrigated areas to areas with no water management at all. The topography also varies. Since water management is extremely important for rice cultivation, it is important to consider and select the technology to be introduced according to the topography and the "degree" of water control, and to introduce it on a trial basis. If water can be controlled at a certain degree, it can be assumed that the number of technologies that can be considered for trial introduction will gradually increase, starting with, for example, the construction of bunds, partial irrigation, and water harvesting technologies.

SARO5 which was cultivated at the time of LMIS visit (before maximum tillering stage, February 23)

IR64 which was cultivation in another area of the LMIS IS (after heading stage, February 23)

Rainfed rice field which was waiting for rainfall (Babati District, March 16)

Rainfed upland rice field (Kyela District, March 25)

Hearing activity in Bagamoyo IS (Scheme manager was in the center)

Hearing activity in Makurunge Ward, which is Rainfed rice cultivation area

Figure 2- 1. Situation of Rainfed rice cultivation survey

2-3. Agricultural Mechanization

2-3-1. Current Situation and Challenges of Agricultural Mechanization in Irrigated Rice Cultivation Areas

1. Current situation

Although there are some differences among ISs in different locations, there are extension staff in charge of rice cultivation, irrigation, agricultural mechanization, and cooperatives. The survey was conducted through DAICO, where the extension staff in charge of each IS contacted IS cooperative leaders, IS operators, TANRICE 2 trainees (key farmers), and intermediate farmers in advance, and interviewed the participants at the cooperative office. The interviews covered the use of agricultural machinery and rice milling machines and their inspection, maintenance, and repair; irrigated rice cultivation; and the operator training they had attended.

A total of 15 irrigation schemes (IS) were visited in this study: 3 in Morogoro, 1 in Pwani, 1 in Kilimanjaro, 1 in Arusha, 1 in Manyara, 3 in Unguja (Zanzibar), 4 in Mbeya, and 1 in Dodoma. Ten of these ISs participated in the TANRICE 2 agricultural machinery training conducted in 2017-19, as shown in Table 1-2 below. Most of the agricultural machinery and rice mills were provided free of charge by the Policy and Human Resources Development Fund (PHRD).

The Current situation of mechanization in the irrigated areas is summarized by agricultural operation as follows.

1) Plowing, harrowing, and soil puddling: Not many IS cooperative organizations own tractors or power tillers (disk plows and rotavators), but the number of individually owned tractors and power tillers is increasing, and wage plowing is becoming more common with farmers who do not own machinery. Manual operation by hand seems to be practiced only in special rice fields, such as those with a small area per rice field, soft soil, or stony soil.

2) Sowing (drilling and dibbling) and transplanting: This is one of the agricultural operations that has not been mechanized and was performed completely by hand. Among these, transplanting accounts for the majority, and although most farmer leaders and intermediate farmers practice straight planting, there are area differences in its spread to the general farmers. Since many farmers hire people to perform transplanting operation, few farmers practice straight planting because it is more expensive than row planting, e.g., 80,000 TZS per acre for row planting and 100,000-150,000 TZS for straight planting.

3) Weeding: Although the existence of hand-pushed weeders (push weeders) is known, they have not reached the point where farmers are building and using them themselves. Some of them are broken and abandoned. Currently, the use of herbicides and weeding by hand are common.

4) Harvesting and threshing: The use of combine harvesters is increasing, although there are regional differences. As the number of combine harvesters increases, the number of farmers who harvest for pay is also increasing.

In Bagamoyo IS, where the harvesting season is different, combine harvesters are brought in from Moshi and Mbeya to harvest for a fee. In Mombo IS and Mvumi IS, combine harvesters have already been replaced, and in Bagamoyo IS, farmers are considering replacing their machines. Reapers and threshers were also seen in Unguja.

5) Rice milling: Rice mills are in operation except for one IS. At the time of the survey, the amount of paddy for milling was decreasing, but the milling machines were maintained in a clean state so that they could be ready for use as soon as a customer arrived. The one location that was not in operation was in need of replacing the transformer installed at the electrical pull-in point, as the voltage had begun to become unstable due to increased power consumption in the area where the transformer was shared. The weighing and packing machines were left in disrepair for the most part. The sensors were not repairable. There are other complaints such as low hourly milling capacity and high electricity consumption, but it is true that this is a major source of income for the cooperative.

Table 2- 1. ISs who participated in the Agricultural Machinery training conducted by TANRICE 2 and the study sites

	Irrigation Scheme	Location		Implementation Year	Training Content	Remarks	Survey Area
		Region	District				
1	Lowewr Moshi	Kilimanjaro	Moshi Rural	2017－2019	Weeder		◎
2	Mussa Mwijanga	Kilimanjaro	Hai	2017－2019	Weeder,CH,MM,LL,Reaper*1		
3	Kirya	Kilimanjaro	Mwanga	2019	CH		
4	Mtambo	Kilimanjaro	Hai	2019	CH		
5	Kivulini	Kilimanjaro	Mwanga	2019	CH,MM		
6	Lekitatu	Arusha	Meru	2017－2019	Weeder,CH,MM,LL,Reaper	PHRD	◎
7	Muungano	Manyara	Babati	2018	CH,MM	PHRD	◎
8	Mombo	Tanga	Korogwe Rural	2017－2019	Weeder,CH,MM,Reaper	PHRD	
9	Bagamoyo	Pwani	Bagamoyo	2019	CH	PHRD	◎
10	Mkindo	Morogoro	Mvomero	2019	CH,MM		
11	Mkula	Morogoro	Kilombero	2019	CH,MM	PHRD	◎
12	Kilangali	Morogoro	Kilosa	2019	CH,MM	PHRD	
13	Rudewa	Morogoro	Kilosa	2019	CH	PHRD	
14	Ilonga	Morogoro	Kilosa	2019	CH	PHRD	◎
15	Mvumi	Morogoro	Kilosa	2019	CH	PHRD	◎
16	Magozi	Iringa	Iringa Rural	2018	CH,MM		
17	Idodi	Iringa	Iringa Rural	2019	CH		
18	Mbuyuni	Mbeya	Mbarali	2018	CH,MM	PHRD	◎
19	Ipatagwa	Mbeya	Mbeya Rural	2018	CH,MM	PHRD	◎
20	Madibira	Mbeya	Mbarali	2019	CH	PHRD	
21	Pakunga	Mbeya	Mbarali	2019	CH		
22	Uturo	Mbeya	Mbarali	2018	CH,MM	PHRD	◎
23	Nakahuga	Ruvuma	Songea	2019	CH,MM		

*1 CH: Combine Harvester, MM: Milling Machine, LL: Land Leveling

Source: Final Report of The Project for Supporting Rice Industry Development in Tanzania (TANRICE 2; 15 November 2012-15 December 2019), Agricultural Training, Extension Service and Research Division, MoA

IS with well-functioning management provides paid rental services to farmers (members of organization) using owned farm machinery, allowing members to farm in a timely manner and continue to have stable yield. Farmers would be able to pay water fees and operation and maintenance fees for irrigation facility as their income stabilizes, and the organization would be able to pay for water rights and other expenses, and repair canals as needed. Owning a rice mill allows for lucrative selling of milled rice and is a major source of income

for the cooperative, creating a virtuous cycle of organizational management. It seems that ISs where machines are left broken and the cost of repairs cannot be afforded are, for whatever reason, not creating a virtuous circle through their management.

2. Operation and Maintenance management survey in Mombo IS (Mombo IS)

One of the additional topics to be covered in the training for farmers and operators is how to plan for the operation and maintenance (O&M) of farm equipment. Since it was necessary to prepare appropriate case studies for the training materials, and since the training was conducted in Mombo IS, Korogwe (220 ha), where a official farmers' organization was formed and several farm machines were used, we conducted a survey on the actual situation of O&M. The survey covered the scheme manager, treasurer, two combine harvester operators, and one rice milling facility operator.

1) Outline of the Organization

The name of the farmers' organization is MISACS (Mombo Irrigation Scheme Agricultural Cooperative Society), which was established and officially registered in 1979 within the framework of AMCOS (Agricultural Marketing Cooperatives Society). It currently has 303 farmers as members, consisting of a scheme manager, board members, and sub-committees in each sector (infrastructure, agriculture, finance, and machinery), as well as a treasurer. The current annual budget is TZS 375,665,000 and the sources of income are considered to be farm machinery services, rice production and sales through MISACS, and storage services using the large warehouse built by PHRD. Note that the organization's membership fee is only due at the time of admission, so it has no impact on the overall income.

2) Combine Harvester

The operation and maintenance of the combine harvester is staffed by a supervisor and five operators. The supervisor records activities and safety controls and reports to the board members and sub-committee as necessary. Two of the operators are fully skilled operators (qualified) and the remaining three are apprentices (tutorship).

The combine harvesters subject to the current operation and maintenance are two Kubota (DC-70) units targeted by the ToT, which were purchased from Agricom in 2020. In making the purchase, MISACS did not select the multiple financing options reportedly offered by Agricom, but instead obtained a separate loan directly from the Tanzania Agricultural Development Bank (TADB). Therefore, the purchase is being made to Agricom as a lump-sum payment. The TADB loan is reviewed based on the submission of a loan repayment plan, which has a three-year repayment period and requires two payments per year. At this point in time, repayment is being made appropriately, but in the event that repayment is delayed, another asset owned by MISACS will be taken as collateral. The amount of this combine harvester is 79,000,000 TZS/unit, plus interest of only 10%.

The two operators have received technical training on the Kubota (DC-60) from PHRD in the past, and at the time of this purchase, Agricom provided them with 5 days of technical training, including safety measures. In addition, the combine harvester will be under warranty for one year.

In terms of maintenance and repairs, daily maintenance, minor repairs, and parts procurement are performed

by the operator, while major repairs, such as gearboxes and engines, are done by a privately owned mechanic. The mechanic is based in Morogoro, and the main reason for this is that he is able to respond more quickly than the distributor Agricom. Especially for combine harvesters, a breakdown during the harvesting process requires an urgent response, and this mechanic, who can start work the next day, is in high demand. The parts purchased by the operators are sold at Same (Kilimanjaro Region), and they do not use Agricom.

Regarding the actual harvesting service, the service fee is divided between MISACS members in Mombo IS and farmers outside IS. The former charges 140,000 TZS/0.5 ha, while the latter charges 150,000 TZS/acre; since one plot is managed in units of 0.5 ha within the Mombo irrigation district, it appears that the area is treated differently inside and outside IS. The harvesting speed of the combine harvester is 0.5ha/45 minutes as a rule of thumb, and the daily work rate is 8 to 10 plots/day. In addition, the number of working days per season within the irrigated area was 10-15 days/season with two units. In addition, the company has been providing services to farmers outside the irrigation schemes since then. There are no seed farmers in or near the irrigated area, and no service for seeds is being provided.

The fuel is diesel, and the empirical fuel consumption was 8-10plot/60L if the soil conditions in the field were good, and 6-7plot/60L if the soil conditions were bad. If outside IS, the plots are transported by truck, but within IS, only the above fuel consumption can be accounted for since the plots are mowed adjacent to each other. Local fuel costs are currently estimated at 3,361 TZS/L, compared to 3,160 TZS/L last year, so future fuel price hikes pose a risk of increased costs.

Personnel costs are paid on a percentage basis. For each job, one operator is assigned two assistants. The unit cost is 10,000 TZS/plot for one operator and 5,000 TZS/plot for all assistants.

To the extent that the above answers can be given, the operators recorded their work in a log book. The records include: (1) date and time, (2) work hours, (3) start time, (4) end time, (5) daily work area, (6) fuel consumption, and (7) issues as remarks.

In addition, when we asked the treasurer about the total amount of money spent per year to cross-check, we found that sales from mowing services amounted to 57,500,000 TZS/year, and costs for parts and repairs amounted to 900,000 TZS/year.

As a supplement, the technology that the operators would now like to see is a stronger HST (Hydro-Static Transmission) and bearings, and further improvement in crawler ground pressure. The operators are aware that ground pressure has been improved in upgrading from DC-60 to DC-70, reducing the risk of sinking in fields with residual moisture, but they wanted further improvements due to the risk of rainfall during the harvest season in the field.

3) Rice milling facilities

MISACS currently operates two rice milling facilities. These were not provided by PHRD, and one was purchased from Poly in 2018, followed by the other in 2020. This rice milling facility was targeted by the ToT and is model number TSMJ20, a machine that includes a pre-cleaner, a stone remover, a husking machine, two milling (polishing) sections, and a grader (rotary shifter). As with the combine harvester mentioned above, the purchase was financed by TADB and paid to Poly in a lump sum. The amount is 51,000,000 TZS/unit plus 10%

interest. The repayment period and method of repayment are the same as for the combine harvester, and repayment has been completed for the machinery purchased in 2018.

The staffing structure was the same as for the combine harvester, with one supervisor (separate from the person in charge of the combine harvester), three operators, and three additional apprentices. Daily maintenance and repairs are performed by the operators.

There is no uniformity in the work charges for rice milling services. Since the quality of the paddy varies, the weight of the paddy and the weight of the milled rice are weighed to determine the milling fee, which is a sensible average of 3,000 TZS/bag (90 kg). The operation starts at 8:00 a.m. and runs for about 12 hours, with a daily workload of 100-120 bags/day/unit as a rule of thumb. The recovery ratio is 60%, not including broken rice. (As a supplement, the irrigated area of 220 ha is cultivated with SARO5 for two seasons, and the average yield is 30 bags/plot per season.)

Electricity at the rice milling facility costs 22,000,000 TZS/year according to accounting records (the unit price at the electricity company is 356.2 TZS/kWh). In addition, the cost for maintenance and repair is 13,500,000 TZS/year/two units, mostly for belts, bearings, and rubber rollers for rice hulling, which are purchased directly from Poly. The rubber rollers were replaced within a week at a cost of 175,000 TZS per set. The rice milling facility also kept a log book, which recorded: (1) date, (2) paddy weight (amount processed), (4) milled rice weight, (3) customer name, (4) amount paid, and (5) remarks.

This rice mill basically provides only milling service, and the farmers sell the milled rice to middlemen who gather at the mill. According to the operators' perception, the quality factors in order of priority were (1) presence of aroma, (2) presence of broken rice, and (3) whiteness and gloss. Whiteness here includes the absence of yellow colored rice (also known locally as pilau). Since the variety is basically fixed at SARO5, the amounts vary depending on (2) and (3). As an example, the current price is 2,000 TZS/kg for rice without broken rice (head rice only), 1,800 TZS/kg for broken rice only, and 1,500 TZS/kg for rice with a large amount of yellow colored rice. The MISACS has a large annual budget and income from farm machinery services, and the introduction of a color sorter could be one of the solutions to this problem.

3. Challenges

Of the 15 ISs surveyed, mechanization in plowing, soil breaking, and harvesting operations has progressed in 14 of them, except for Ngano IS in Kyela Region. It is assumed that this is due to the fact that many farm machines were introduced to IS by large farms and PHRDs that introduced machines early on, and the business model of plowing and harvesting using tractors, power tillers, and combine harvesters has been verified. This situation has led to cooperation between major agricultural equipment dealers and financial institutions, and the relative ease of financing power tillers, tractors, and combines to farmers and cooperatives is thought to be a major factor in the increase.

Table 2- 2. Rice Cultivation Area and the Number of Agricultural Machines in Use

Region	Cultivated Area (ha) a	Rice Cultivated Area (ha) b	Proportion of Rice Cultivation (%) b/a	Number of Agricultural Machines by Ownership in the Region*1					
				Tractor		Power Tiller		Harvester*2	
				Private	Group	Private	Group	Private	Group
Morogoro	411,122	275,745	67.1	978	41	479	22	55	3
Pwani	59,206	17,471	29.5	380	35	48	13	6	4
Mbeya	322,088	99,566	30.9	497	76	3,696	94	122	35
Katavi	154,877	36,015	23.3	67	2	—	—	1	—
Ruvuma	388,537	49,694	12.8	37	2	11	—	—	—
Shinyanga	485,496	173,771	35.8	298	15	105	10	1	—
Mwanza	136,576	21,494	15.7	172	21	112	34	—	—
Simiyu	398,288	40,987	10.3	596	33	79	35	—	—
Geita	74,038	21,397	28.9	96	1	—	—	—	—
Tabora	733,985	215,767	29.4	53	1	355	5	17	—
Kilimanjaro	139,786	3,693	2.6	527	25	131	8	25	—

Source: Area under cultivation: National Sample Census of Agriculture 2019/20 National Report, August 2021, The United Republic of Tanzania and Agricultural Routine Data System (ARDS) 2020/21, Ministry of Agriculture

*1: Only available agricultural machinery is shown in the table.

*2: Most of the harvesters are combine harvesters, with a few reapers and threshers.

When we asked about sales results at the Igurusi branch of Agricom, one of the major agricultural machinery dealers, we were told that the number of power tillers sold in recent years (the last three years or so) was about 1,000 units and combine harvesters more than 100 units. Although these figures are for the entire country, 80% to 90% of the sales are believed to be in the southern highlands (Iringa, Mbeya, Songwe, Rukwa, and Katavi Regions). Since Table 2-3 below shows the figures for 2020/21, it is possible that the number of sales in Mbeya and Katavi Regions may have increased further based on the information obtained from the above interviews.

According to Table 2-2 above, Morogoro has the largest area of rice paddies (275,745 ha), followed by Tabora (215,767 ha), Shinyanga (173,771 ha), and Mbeya (99,566 ha). A comparison of the number of tractors, power tillers, and combine harvesters in order of paddy area between Mbeya and Morogoro, where many IS are located, and Shinyanga and Tabora, where rainfed rice cultivation is the main crop, clearly shows their diffusion. In particular, the number of combine harvesters in Shinyanga and Tabora is low, at 1 and 17, respectively, compared to 157 and 58 in Mbeya and Morogoro, respectively. The most notable is Kilimanjaro Region, where the number of combine harvesters is conspicuous despite the relatively small area of rice paddies. This is consistent with information we have obtained from interviews that the machines are not only used in Kilimanjaro but are also transported to other regions for cultivation at different times of the year.

In the irrigated paddy field area, mechanization of the farming machinery seems to be progressing rapidly, not only in plowing, soil breaking, and puddling, but also in harvesting, judging from the number of machines in use and the actual number of harvesting for hire. The operation and maintenance of agricultural machinery has been acquired by cooperative and private operators (individuals and companies) through on-the-job training. When farm machinery is purchased from a major agricultural machinery dealer, the dealer's instructor provides on-site instruction on pre-startup inspection, safety confirmation, operation procedures, and simple maintenance for safe use based on manuals, while the operator actually touches the machinery. The owner or operator

performs the maintenance for which parts are readily available, such as replacing consumable parts, while repairs to the engine, drive system, and electrical system are left to the dealer. In Japan, purchasers receive the same kind of instruction from dealers, agricultural cooperatives, and other sales outlets as in Tanzania, and acquire skills through on-the-job training. Further detailed research is needed, but it is unlikely that the current system is causing major problems in the dissemination of agricultural machinery.

In the case of Muunagano IS, the operator is currently using two Daedong combine harvesters provided by the PHRD and is maintaining them well. The Daedong combine harvesters have been used for more than 1,000 hours in Bagamoyo IS, and then parts became difficult to obtain because the dealer withdrew from the market, so the combine harvesters are still in a broken condition. The elderly operator of the Muunagano IS has been working for many years on a NAFCO (National Agricultural and Food Corporation) wheat farm in Basotu town (Manyara Region). He started working for IS after his retirement. He is familiar with the structure of combine harvesters, and when parts need to be replaced, he directly contacts the individual who used to be a dealer of Daedong's combine harvesters and personally purchases the parts from the country of manufacture. Such cases may be rare, but we assume that skilled operators have been trained through on-the-job training by having long years of experience as combine harvester operators. The same is true for rice mills. In large rice-producing areas, there are private rice mill clusters, where dozens of rice mills are gathered. Since information on rice mill operators and rice milling is shared by the rice milling cooperatives, they are operated with a private-sector business sense, and personnel related to rice milling machines are trained through on-the-job training.

2-3-2. Current situation and challenges of agricultural mechanization in Rainfed rice cultivation areas

1. Kyela District, Mbeya Region (TANRICE 2 training participant area)

Mechanization in rainfed rice production areas differs significantly from that in irrigated rice production areas, and has not progressed very far. In the rice farming areas, plowing, harrowing, and puddling are mainly done by oxen, sowing (broadcasting and dibbling) is done by hand, weeding is done by herbicide and hand, and harvesting and threshing are generally done by hand. Thus, tractors, power tillers, and combine harvesters, the main agricultural machinery for rice cultivation, are not widely used in Kyela Region. Comparing Kyela District, where rainfed rice is the main crop, and Mbarali District, where irrigated rice is the main crop, there is a big difference in the number of rice farming households and cultivated area between the two, but as Table 1 below shows, the number of rice machines in Kyela District is low. This is presumably due to the instability of rice yield in rainfed rice cultivation. The farmers are trying to minimize labor and financial investment to cope with the unstable rainfall in rainfed rice cultivation. The future direction of the project is not to promote mechanization but to combine improved cultivation techniques with labor-saving tools.

2. Rainfed paddy field area adjacent to Muunagano IS, Babati District, Manyara Region (not covered by TANRICE 2 training)

Adjacent to the IS, the area can be cultivated for rent and harvested for rent. The cultivation method is to conduct plowing and harrowing with a tractor and power tiller, and then to broadcast seeds.. It seems that harvesting in the rainfed rice area is a major source of income for the farmers' organization. One of the reasons

for the lack of mechanization in Kyela District is that most of the paddy fields in Kyela are rainfed. However, in the Kyela area, it is quite possible that mechanization will spread to the area in the way of renting plowing and harvesting as farmers who own relatively large paddy fields with good water conditions purchase machinery, as seen in the paddy field areas around IS.

Table 2- 3. Availability of agricultural machinery in the main rice growing regions of Mbeya

Region	District	Tractor	Power Tiller	Conbine Harvester	Rice Farming Households	Remarks
Mbeya	Busokelo	4	—	—	—	
	Chunya	16	6	—	Some Rainfed Rice	
	Kyela	55	93	8	Many Rainfed rice, some irrigated rice farmimng	
	Mbarali	448	3,651	144	Many Irrigated rice, some rainfed rice farmimng	
	Mbeya	17	14	3	—	
	Mbeya Rural	18	26	1	Some Irrigated rice, some rainfed rice farmimng	
	Rungwe	15	—	1	—	

Source: Agricultural Routine Data System 2020/21, Ministry of Agriculture

2-4. Current Market Situation and Challenges in Rice Cultivation Areas

The study covered Shinyanga, Kishapu, and Msalala Districts in Shinyanga Region and Mlimba and Mvomero Districts in Morogoro Region. In both regions, rice was an important source of income as a cash crop. However, the reality is that most of the villages do not have grain warehouses or large rice mills nearby, and individual farmers generally sell paddy to middlepersons. Therefore, there was a challenge that farmers could not take the initiative in setting the sales price as a whole. In addition, in the visited villages, there were no activities to increase the added value of rice by farmers. In response to these challenges, "private rice millers" and "farmers' groups" are conducting the following activities in the surveyed areas of both regions.

2-4-1. Shinyanga Region

1. Private Rice Millers and Distributors

Musoma Food Company (MFC, Shinyanga) and Kishapu Food Processing (KFP, Kishapu) were involved in the project as companies that purchased paddy produced by farmers under the CARI project and milled and sold it. Although the project has already been terminated, KFP continues to purchase paddy from small-scale farmers (cultivating 1-10 acres). The purchasing method is that agents are assigned to each target area (wide area), and they purchase quality rice through cash transactions. When a certain amount of rice is purchased, 4-ton or 10-ton trucks are sent to the production area to deliver the paddy to the respective rice mills. Agents purchase directly from farmers and do not appear to purchase through middlemen. These efforts are not limited to these two companies. In places such as Kahama and Kagongwa, where there are many rice mills and distributors, the key is how to gather as much good quality rice as possible, so each company offers a wide variety of services. For example, they offer free storage in mill-owned warehouses, interest-free loans of cash to pay workers for planting, weeding, and harvesting (repaid after harvest), and procurement of seeds and chemical fertilizers (repaid after harvest).

Regarding contract farming, the farmers said that contract farming is difficult because they want to sell their rice at the highest possible price, so even if they have a contract, if a company appears who will buy it at a slightly higher price, they will sell it to that company. The companies also want to buy good quality rice at a fair price (low price), so it is difficult to set the price, and farmers complain that the price is too low.

In addition, rice millers who specialize only in custom (toll) rice milling have introduced new rice milling units and graders to meet the needs of their customers, and they also offer services such as paid or free storage at grain warehouses.

2. Farmers' groups (from production to milling and sales)

In 2012, a group of farmers, which started as Village Community Banks (VICOBA), established Oxfarm International with the support of Oxfarm International, and in 2012, a group of farmers started a joint shipment of paddy with the support of Oxfarm International. Technical guidance on rice cultivation, including introduction of improved rice varieties, leveling of plots, seedling cultivation, planting in regular rows (25 cm x 25 cm), weeding, fertilization, threshing, and drying, has increased SARO5 yields up to 3.6 tons/acre when rainfall conditions are favorable. Seed was produced by one of the members who received QDS (Quality Declared Seed) training from ASA. After that, when the group built the rice mill building on their own, Oxfarm offered to support the rice mill plant, so they built a rice mill and grain warehouse with funds from VICOBA (about 70%) and DADP (District Agriculture Development Plan) from the district (about 30%). The company is now in good business condition.

3. Agricultural Marketing Cooperatives Society (AMCOS)

A warehouse of UVIBUKA AMCOS LTD was built in 2018 in a corner where many rice mills are gathered in Bulige village, Msalala District. Currently, the company has 210 members and only conducts storage business of maize, sunflower seeds, and paddy, while sales are conducted by individuals. Microcredit and WRS (Warehouse Receipt System) are not available. The storage fee is 1,500 TZS/bag (90-100 kg), and a maximum of 10,000 bags can be stored. Non-members can also be accepted for storage, and the fee is the same as for members.

2-4-2. Morogoro Region

1. Private Rice Millers

In Ifakara township (located in corner of Mlinba District), there are more than 100 rice mills of various sizes. Most of them specialize in custom (toll) rice milling. According to interviews with two of the largest rice millers, some rice is brought to the mill by middlepersons, while others are used by farmers from a specific village, based on a relationship of trust established between the miller and the farmer. The services offered to farmers include rebuilding the cost of harvesting (no interest), storing paddy (free of charge or for a fee), and connecting farmers with rice distributors by showing them samples of white rice. According to the service providers who charge storage fees, they issue a deposit slip when the rice is received, and if it is lost, the management is responsible for the loss, so they ask the farmers to understand that they must charge 1,500 TZS/bag as an

administrative fee. Some of the rice millers also lend the middlepersons the resources to purchase paddy.

When survey team asked a rice distributor at the mill about the price difference between rice grades and varieties, he replied that local varieties (long grain and aromatic) such as Zambia, Mbawambili, and Kalamata are sometimes lumped together as Supa, and that Grade 1 rice is currently 2,500 TZS/kg and Grade 2 is Grade 1 is currently 2,500 TZS/kg and Grade 2 is 2,300 TZS/kg. The improved variety SARO has both short-grain and long-grain varieties, and they do not buy short-grain varieties. The improved long grain variety SARO5 (TXD306) and Cherehani are purchased, but the price is lower than the local variety, at 2,200 TZS/kg for grade 1 and 2,000 TZS/kg for grade 2.

2. Farmer group (System of Rice Intensification, SRI group)

After the CARI project was completed, Kilombero Plantation Limited (KPL), the buyer of SARO5 produced by the farmers, went bankrupt at about the same time, and the farmers who lost a reliable seller and the paddy fields they had rented from KPL organized a SRI group under the leadership of an agricultural extension officer. The group was active in a small way. Currently, the group members do not sell their rice jointly, but some members sell paddy individually to middlepersons, and other member turn paddy into milled rice and sell it to distributors. Agricultural extension officers were in the process of exploring sales through AMCOS.

Rainfed rice field in Msalala District (before rainfall)

Rainfed rice field in Shinyanga District (after rainfall)

Oxen plowing in a small plot of Rainfed rice field (2 cows)

Oxen plowing in a large plot of Rainfed rice field (4 cows)

Interviews with farmers in Mlinba District

Interviews with SRI group in Mlinba District

Figure 2- 2. Photos of the survey on Rainfed rice cultivation by agricultural machinery

2-5. Quality Seed Production

Based on the results of the rice seed survey conducted by Sokoine University of Agriculture, which has been requested to conduct a re-entrusted survey, necessary information on the process from production to distribution and utilization of quality seeds was reviewed and organized to establish the implementation method of Subject Matter Training (quality seed production) in TANRICE 3, and additional surveys on seed (production, inspection, etc.) at concerned organizations were conducted..

In seed production, it is important to ensure "quality" above all else, but it is also important to encourage farmers to understand the benefits and importance of using quality seed and to actually use it, and it is also necessary to secure enough quantity to provide it.

2-5-1. Variety

Regarding varieties, 22 rice varieties were registered as "approved varieties" at the time of the survey, including both lowland and upland rice varieties. Although far fewer than the more than 190 varieties of maize, registration began before the 1950s and has continued through to TARI-RIC2 in 2020, including NERICA (New Rice for Africa) (4 varieties) in 2009. The characteristics of the registered varieties have changed according to the "demand" and "purpose" of the time, but the main points are yield, environmental adaptability, aroma, disease resistance, drought resistance, and growing period (early maturity or medium maturity). Among them, SARO5 (TXD306) and Supa, which are particularly aromatic and expected to produce high yields, are grown by many farmers. On the other hand, depending on the natural conditions and cultivated environment of each farmer, there are differences in the number of growing days and plant height, and especially in rainfed and lowland rainfed rice cultivation areas, not only early maturity varieties but also late maturity varieties are selected based on farmers' own experience. In addition, many local varieties, although unregistered, exist and are cultivated in various regions (areas), reflecting preferences related to eating quality such as taste and competitiveness in the market. From the viewpoint of seed production, it is necessary to cultivate and produce seeds of high purity without mixing with other varieties. In actual cultivation, there are many farmers who cultivate each variety separately. In rainfed rice-cultivation areas, there are also farmers who dare to mix various varieties (e.g., varieties with different growing period and plant height) in order to diversify the risk such as

without harvesting any varieties.

2-5-2. Seed

Most of the farmers (about 98%) use their own seeds collected from the previous year's harvest. Only a few cases of "seed" purchased from the Agricultural Seed Agency (ASA), a specialized seed production and marketing organization, or from seed companies were found. In this study, the survey team visited irrigated and rainfed rice cultivation areas, research institutes, seed production and testing organizations, and conducted interviews regarding the use of quality seeds. Through that survey, the following issues related to the use of quality seed were identified.

- Lack of awareness of the importance of using quality seed
- Lack of opportunities to experience the productivity and quality benefits of using quality seed
- Lack of understanding of quality seed itself (including confusion between seed and varieties)
- Existence of differences in prices and competitiveness in the market due to varieties of quality seed and lack of information on these differences.
- Lack of knowledge and skills to produce quality seed themselves
- Access problems for using quality seed
- Locational imbalance problems of institutions related seed production
- Deficiencies of the overall system, structure, etc. to provide farmers with access to quality seed

2-5-3. Production Institutions

Seed production activities are conducted at research institutes such as TARI and at seed production with marketing organizations such as ASA.

1. Current situation

This section was described from the viewpoints of high quality seed production techniques and agricultural machinery, equipment, and devices required for seed production.

In terms of technology, researchers at TARI have been storing valuable and high quality seeds such as BS and FS in less favorable conditions (high temperature, high humidity, etc.). However, they already have enough knowledge and techniques about seed production, so there are generally no problems in terms of technology. ASA produces rice seeds through broadcasting method at only Kilangali seed farm, and during the survey, there were few missing plants caused by improper leveling, and there were few different varieties (off-type plants). Weed control was generally appropriate through herbicide application. Three varieties such as SARO5 (TXD306), TXD 88 and Supa were cultivated, and measurements were taken to avoid mixing with other varieties by cultivating them at a proper distance from each other. Although the average yield was reported to be 2.5 tons/ha, the yield is limited by broadcasting method, even with proper fertilization management.

2. Challenges

It can be understood ASA's perspective that securing quantity is important, but from the viewpoint of ensuring quality or both quality and quantity, it is necessary to consider reducing cultivation area, conducting drilling or

transplanting instead of broadcasting, and improving the yield per unit area (total production does not change even if cultivation area is reduced) by making it easier to manage field such as weeds and especially, different varieties (off-type plants) because it is extremely difficult to remove or separate seeds of different varieties after harvesting. Therefore, there is a need for technical improvements in TARI, particularly in ASA. In addition, certain agricultural machinery, equipment, and devices are necessary to ensure quality and increase production efficiency for seed production activity at both organizations.

2-5-4. Inspection Organization

1. Current situation

Tanzania Official Seed Certification Institute (TOSCI) is responsible for all field inspections, laboratory tests, seed certification (approval), and training. It is necessary to implement and expedite accurate and appropriate inspections and tests, as well as to respond to the need for increased inspection areas, number of target persons, and samples to be tested.

2. Challenges

There are challenges related to seed inspection (field inspection and laboratory test) techniques, training activities, agricultural machinery, equipment, and devices required for seed inspection activities. Laboratory test is conducted based on the 'International Rules for Seed Testing' developed by the International Seed Testing Association (ISTA). However, it was said at SUA that field inspections and training conducted by TOSCI are difficult to be properly implemented due to a shortage of inspectors. TOSCI covers a wide range of crops and operates nationwide, leading to delays in seed certification procedure and work. TOSCI also recognizes the shortage of inspectors and the need for efficient and accurate inspections and tests through the improvement of inspector assessment and testing techniques. Furthermore, there is a demand for the promotion of training and development of inspectors to fill the shortage of TOSCI inspectors. On the other hand, there is a lack of sharing information such as field inspection and training manuals, resulting in many opaque aspects regarding field inspection processes, content, and the actual situation of QDS producers and inspector training. Therefore, it is necessary to collect and accumulate detailed information and based on the results, confirm and improve the required techniques (accurate assessment of cultivation conditions, identification of the presence and types of different varieties (off-type plants), detection of pests and diseases, etc.) to enhance inspection activities. Additionally, for the accurate and appropriate implementation of seed inspection activities and to respond promptly to the increasing number of inspection targets for the production of high quality seeds, adequate inspection-related equipment and devices are necessary.

2-5-5. Training Institutions

1. Current situation, Challenges and Cooperation

1) Implementation of training related to quality seed production at KATC, MATI, etc.

2) Implementation quality seed production activities at these training institutes.

As part of TANRICE 3 activities, 1) conducting training as Subject Matters Training specific (quality seed

production) and 2) cooperating with training institutes in seed production activities are identified as key measures. Regarding 2), KATC staff including tutors have already received training by TOSCI, and MATI-Igurusi also is in the process of applying for training. If TOSCI officially approves the institutes (fields and facilities) and personnel as "seed production institutions", they will be legally allowed to conduct not only training but also seed production activities at each training institute. Regarding 1), it is practical to conduct training on the production (multiplication) of Certified Seed (CS) or QDS, from the perspective of ensuring quality and providing direct supply and dissemination to farmers. Furthermore, considering the selection of varieties based on the participants (farmers) and local condition of their fields, as well as precautions regarding different varieties (off-type plants), it is necessary to consider conducting focused training on core seed production (multiplication) techniques to ensure that the benefits of using quality seeds are understood by participants (farmers).

2-5-6. Other

1. Training of district agricultural officers as QDS inspectors

If district agricultural officers (extension officers, etc.) were trained and certified as QDS inspectors by TOSCI, they would be able to take the initiative in supervising QDS production by farmers.

2. Process of implementing seed production activities by farmers

In order to stably increase rice production in the country as a whole in the future, it is important that farmers recognize the importance of utilizing better (quality) seed, that they are able to produce themselves and use quality seeds. In the future, it would be desirable to establish a "system" or "structure" that enables farmers to easily access, purchase, and cultivate quality seeds. Rainfed rice cultivation areas are not necessarily suitable for seed production because the environment is affected by rainfall and flood water, and water, which is important for rice cultivation, cannot flow in and out as it should. Therefore, it is preferable to start seed production in irrigated rice cultivation areas with key farmers who have abundant knowledge, technology, and experience, and then gradually introduce seed production in rainfed rice cultivation areas when farmers with knowledge and technology have grown up in rainfed rice cultivation areas.

3. Revision of Existing Training Materials

3-1. Rainfed Rice Cultivation

3-1-1. Existing Materials and Training

1. Training (dissemination) methods in line with Agenda 10/30

Improvements and suggestions regarding training materials, number of days, content, etc. are described in the "Results of ToT Training" section. In relation to the training activities in TANRICE 3, this section specifically describes the "Agenda 10/30" announced by the President in April 2022. This is the "Agricultural Transformation Plan" and aims to achieve an annual growth rate of 10% in the agricultural sector by 2030, targeting the following 8 areas.

1） Agricultural financing
2） Seed production (Seed multiplication)
3） Markets
4） Irrigation (Irrigated agriculture)
5） Agricultural Extension (Extension Services)
6） Research and Development
7） Strategic Crops (Strategic Food and Cash Crops)
8） Technical Innovation (Technology and Innovation)

In this context, it is particularly important to point out that, in relation to training, "agricultural extension (extension services)" has been a major focus of training in TANRICE 2, with extension officers also participating in training during baseline surveys, group training, and field training. However, they have not played a major role in the training, but rather have been "participants" in the training. However, the "Agenda 10/30" mentioned above plans to increase the number of agricultural extension officers from the current 8,000 to 15,000, which means that extension officers are key to improve extension services and technology dissemination, and the intention is to increase their number and strengthen their role in the field. The intention is to increase their number and strengthen their role in the field. Naturally, it is extremely important to develop activities in line with these government policies. It can be said it is important to incorporate more extension officers when conducting training in TANRICE 3 in the future. In the case of rice cultivation in irrigated areas, it does not seem too difficult, based on past experience, for farmers who have mastered land leveling and regular row planting at the training center to disseminate these practices to neighboring farmers on a "farmer to farmer extension approach" basis. However, it is sure that the activities of extension officers with specialized knowledge are indispensable for the dissemination of rainfed rice cultivation techniques, where the cultivation environment varies greatly depending on the amount of rainfall and topography. Therefore, it seems necessary to consider a training method in which training at each training institute is conducted mainly by tutors and extension officers play a central role in on-site training.

2. Seed production (multiplication)

Seeds used in rainfed rice cultivation areas have been used for many years by farmers who are familiar with

the local environment, so careful consideration should be given when introducing new varieties.

3. Fertilization

Rainfed rice cultivation is greatly affected by rainfall, and fertilizer may be wasted if there is no rain or water after basal application of fertilizer. Therefore, based on local conditions, it is preferable not to apply base fertilizer, but to apply additional fertilizer as topdressing after confirming the growth of rice plants..

4. Water management (irrigation and drainage)

In rainfed rice cultivation, water management in the field, i.e., drainage of excess water and water harvesting techniques to secure insufficient water for irrigation, are important.

3-1-2. Implementation of ToT Training

1. Objectives and contents

ToT (Rainfed rice cultivation) was conducted as follows.

(1) Date: July 18-21 2022 (4 days)
(2) Venue: MATI-Ilonga
(3) Participants: 18 (KATC: 5, MATI-Ilonga: 2, MATI-Igurusi: 2, MATI-Tumbi: 2, MATI-Ukiriguru: 1, MATI-Mtwara: 2, SoA: 2, Zanzibar MoA: 1)

The objectives were to review TANRICE 2 materials, confirm basic (core) technologies for rice cultivation including rainfed rice cultivation, share direct seeding technology as an additional important technology for rice cultivation under rainfed conditions, exchange opinions on more effective ways to disseminate technologies to farmers, and field practice (land preparation, bund making, seed preparation, leveling, transplanting, direct sowing methods, etc.) and formulation of a training plan for farmers. The participants generally had a good grasp of basic rice cultivation techniques and a wealth of knowledge. On the other hand, the number and location of training sessions for rainfed lowland rice cultivation in TANRICE 2 were limited compared to those for irrigated rice cultivation, and there was a lack of experience in terms of practical understanding of rice cultivation under rainfed conditions, technologies that can be introduced, and methods for improvement (modification), and it appeared that it was not easy to break out of the "irrigated rice cultivation" technology framework.

It is true that under irrigated conditions, it is possible to achieve high yields by making bunds between rice fields, leveling the field, planting in regular row with low height seedlings of improved varieties made in the nursery, weeding, applying a lot of fertilizer, managing water according to rice growth, dropping water when necessary, and harvesting at the right time. Since TANRICE, many regions and farmers who have participated in irrigated rice cultivation training have achieved high yields. However, rainfed areas are not in irrigated schemes or in irrigated areas with irrigation facilities, but areas that rely mainly on rainfall and river floodwater for irrigation water. When training farmers and extension officers in such areas to improve yields of rainfed rice cultivation (in the region), it is necessary to go back to the basics of rice cultivation technology, away from "irrigated rice cultivation" where water can be freely taken in and out at any time, and to think more flexibly

and flexibly. In other words, the characteristics of the region should be understood, core technologies should be tentatively selected that can be introduced by farmers, and trial introductions should be made. Such a process of trial and error would be necessary for the introduction of the technology and its acceptance by farmers.

2. Methods of technology transfer (dissemination)

Regarding technology transfer to farmers, there are many tutors seemed to want to present and convey as much knowledge and technology accumulated through their past activities as possible, perhaps because of their position as "tutors. However, it is necessary to focus on core technologies, taking into consideration that farmers (recipients) may forget even if a lot of knowledge and technologies are presented at once, and that the technologies that can be introduced may be limited depending on the situation in the field.

3. Review of training materials

The following are the main points of common understanding and suggestions for modifications and additions that were shared from the review of the materials by the participated tutors.

- "Guidelines for Rainfed Rice Cultivation Training Course

1) To clarify the "objective" of each component, such as Baseline Survey, Study tour, Residential training, 1st Infield training, etc., by clearly stating each at the beginning of each component.
2) It is preferable to increase the time for Residential training from the current "1 day" to "2 days" whenever possible, as the time is short, and the content of the practical training is shallow.
3) The "Farming Diary" is often too complicated for farmers and is not written down, so a more concise version should be prepared and replaced.
4) Demonstration plots should not be limited to the key farmers' plots, as was the case in the previous training in TANRICE 2, but could be set up in other farmers' plots, and in principle should be managed by the key farmers and local extension officers.
5) The "name (title)" of several items in the Timetable of each component should be changed to accurately represent the content.

- About "NERICA Cultivation Training Course Guide

1) It is preferable to change the name of the material to "Upland Rice Cultivation Training Course Guide" if possible, while keeping the description and explanation of "NERICA" and including more upland rice related information (varieties, etc.).

ToT (Day 1): Dr. Mafuru, Director (center) and Mr. Felix, Principal (left)

ToT (Day 2): TG Leader explains basic (core) rice cultivation techniques

ToT (Day 3): Practical training for participants to make bunds between rice fields (at MATI-Ilonga)

ToT (Day 4): Comments by Mr. Nakagaki to the participants

Figure 3- 1. Photos of ToT training on Rainfed rice cultivation

3-1-3. Implementation of farmer training

The trial farmer training (rainfed rice cultivation) was conducted as follows.

(1) Date: November 2-4 2022 (3 days)

(2) Venue: Ihimbili Village (Kandawe Ward, Magu District, Mwanza Region)

(3) Instructors: Rice Agronomy TG members (leader (KATC), sub-leader (MATI-Tumbi), members (MATI-Ilonga: 1, MATI-Ukiruguru: 2)

(4) Participants: 34 farmers (20 men, 14 women), 1 Ward Agricultural Extension Officer (WAEO), 1 District Crop Officer (DCO)

(5) Schedule:

Date and Time	Programme	Remarks
November 2 (Wed.)		
08:30 - 14:00	Meeting, Courtesy call to DED/DAICO/Ward/Village offices Confirmation of training venue/site Discussion and confirmation of training contents, method, etc.	
November 3 (Thu.)		
08:30 - 09:30	Registration of the farmers	

09:30 - 10:00 10:00 - 15:00	Opening Utilizing of Quality seed, Seed preparation (L&P) Land preparation and Bund making (L&P) Nursery preparation and sowing (L) Q & A	
November 3 (Fri)		
9 :00- 9 :30 9 :30-12:00 12:00-13:00 14:00-16:00 15:30-16:00	Registration, Adaption of schedule of the day, etc. Discussion 1: new contents (Continue) Lunch Discussion 2: Revise of guidelines and material Summing up of the day	
September 8 (Thu.)		
08:30 - 09:00 09:00 - 15:00	Registration of the farmers Sowing methods (Drilling & Dibbling) (P), Making Demo Plots (P) Transplanting (P) Q&A	

(6) The survey team proposed the following items and exchanged opinions with the lecturers and others, and reached an agreement.

1) Narrowing down the technologies (core technologies) to be presented

2) Necessity of adjustment and modification of the training content according to the situation in the field (in this case, increase in training on direct sowing technology)

3) Implementation of training and acquisition of technology through formulation and management of demonstration plots

4) Importance of implementing and following up on training based on close coordination and cooperation with extension officers and district agricultural officers in the field.

- Training materials and guidelines will be adjusted based on this trial training and reflecting the results of exchanges of opinions with tutors and others after the training.

Lecture (use of quality seeds)

Practical training (seed sorting: salt water selection)

Practical training (land preparation and making bunds

Practical training (fertilizer application)

Practical training (drilling)

Practical training (dibbling)

Figure 3- 2. Photos of Rainfed rice farmer's training

3-1-4. Revision of Training Materials

1. Training materials (guidelines, etc.)

1) "Rainfed Rice Cultivation Training Course Guidelines"

(1) To clarify the "objectives (goals)" of each component, such as baseline survey, study tour, residential training, and the first training in the field, the "objectives" should be clearly stated at the beginning of each component.

(2) Residential training should be increased as much as possible from the current "1 day" to "2 days" because of the short time and lack of practical training content.

(3) The "Farm Diary" should be replaced by a more concise one, as it is often too complicated for farmers to write.

(4) Demonstration plots should not be limited to being set up in the key farmer's field as in the previous training, but may be set up in other farmers' fields, and in principle should be managed by the key farmer and local extension staff.

(5) The "name (title)" of some items in the timetable of each component of the guidelines should be changed to accurately represent the content, for example, from "Results of the verification test" to "Results of the test," from "Orientation for the demonstration plots" to "Guidance on preparation of the demonstration plots."

2) "NERICA Cultivation Training Course Guide

(1) In order to include more information related to upland rice (varieties, characteristics, etc.), it is desirable to change the name of the document to "Training Course Guide for Upland Rice Cultivation" including the description and explanation about "NERICA".

2. Contents, items, etc.

In considering the contents and items of the TANRICE 3 training course on rainfed rice cultivation, the following items were shared with the tutors as important technical points through surveys, ToTs, and training to farmers.

1) Consideration and introduction of technology according to water use conditions

The "Rainfed rice cultivation areas" may vary from areas where water cannot be controlled at all (e.g., flooded areas) to areas where minimal control is possible. This means that they range from areas that are as close as possible to irrigated areas to areas with no water management at all. The topography also varies. Since water management is extremely important for rice cultivation, it is important to consider and select the technology to be introduced according to the topography and the "degree" of water control, and to introduce it on a trial basis. If water can be controlled at a certain degree, it can be assumed that the number of technologies that can be considered for trial introduction will gradually increase, starting with, for example, the construction of bunds , partial irrigation, and water harvesting technologies.

2) Trial introduction of various varieties

In rainfed rice cultivation areas, where irrigation water is dependent on rainfall and river flooding, the timing of rainfall often varies by area (region) and cropping season, with some areas remaining flooded for long periods of time and others facing drought as the water recedes quickly. In rainfed rice cultivation areas, farmers often cultivate many local varieties to diversify risk. It is important from a marketing (sales) perspective to understand the characteristics of these varieties as much as possible, and to conduct trial cultivation of various varieties with different characteristics and properties, such as early maturing varieties including upland rice varieties as a measure against water shortage and drought in order to select suitable varieties for the area (region).

3) Use of pure seeds and seed selection by water

Generally, farmers cultivate many varieties under rainfed conditions to manage risk, and the use of pure seed is recommended to achieve high yields through uniform field management practices. If pure seed is not available, it is also recommended that, at a minimum, seed selection by water be conducted to obtain vigorous seed.

4) Land leveling and creating bund

These are important operation in terms of efficient use of limited water.

5) Shifting from broadcasting to drilling

When plowing is done by cattle or other animal power, it is difficult to prepare the field sufficiently, and there is a possibility of poor germination due to water stagnation in lower place. In direct sowing, weed control is considered to be the most serious yield limiting factor. Therefore, from the viewpoint of easiness of weeding, it is important to facilitate weeding operation as an important task to achieve high yield by shifting from broadcasting to the drilling or dibble method.

6) Trial introduction of water harvest technology

In rainfed rice cultivation, water harvesting technology as a method for effectively draining surplus water and securing water for irrigation is an important technology related to water management.

7) Consideration of timing and method of fertilizer application

Rainfed rice cultivation is highly dependent on rainfall, so even if fertilizer is applied as basal dressing, the fertilizer may be wasted if there is no rain or water. Therefore, based on the environmental conditions of the target area, it is desirable to apply fertilizer as a top dressing after checking the growth of the rice plants, without applying fertilizer as basal dressing in principle.

8) Diversification of cropping season

Diversification of the maturity period by scattering the sowing time is effective in preventing bird damage during the maturity period.

9) Transition from random planting to line planting

As a subsequent process, a transition from random planting to line planting is necessary.

3-2. Agricultural Machinery

3-2-1. Existing Materials and Training

In TANRICE 2, it was observed that users of agricultural machinery in various regions did not keep work records (logbooks), making it difficult to grasp the actual situation, and that there were cases where users could not cover the cost of using agricultural machinery and left it after it broke down. Therefore, it is desirable to support the creation of a system that enables users to use agricultural machinery for a long period of time by instructing them to create an operation and maintenance management plan and to make it a habit to keep work records during the agricultural machinery training.

In addition, TANRICE 3 is expected to focus more on rice cultivation in rainfed lowland rice cultivation areas. One of the issues regarding agricultural machinery in the area is that farmers cannot increase the amount they can pay for agricultural machinery services because the area per plot is small and the yield per crop is also small. In the harvesting process, combine harvesters are used even for small plots, but it may be useful to provide information on the price of harvesting services and whether it is more economical for farmers to hire laborers to harvest the paddy manually.

In rainfed lowland rice cultivation, not only is the area of each plot small, but the landform is rugged and the access to the field is also poor. This is likely to lead to accidents when the power tiller or combine harvester moves over the sloping terrain as they perform their respective services. Local distributors include safety measures in their initial training, but incorporating safety measures again in the training would help reduce the risk of accidents.

In harvesting, it is necessary to understand the actual local conditions, but it is assumed that access to rice mills of medium size and above will become more difficult and that there will be more opportunities for farmers to either set up small rice mills in the villages or bring their rice to distant mills at the cost of transportation. One measure that could be taken is to provide support for mobile rice mills that include a small rice milling

machine and a stone remover, as has been done in the past, or to support the maintenance of rice milling machines at small rice mills.

Furthermore, at present, it is difficult to determine which areas are highly productive from the standpoint of water availability in the vast area of rainfed lowland rice cultivation. The survey showed that the potential areas could be identified using satellite imagery proposed by the private sector, followed by aerial drone photography to provide a more detailed picture of the area and topography, which could be useful for land use planning by experts and local rice farmers. Although these are ICT technologies and different from conventional agricultural machinery, the actual users are likely to overlap with the agricultural machinery service industry, and technical training could be provided in conjunction with these technologies. The Director General of the Department of Mechanization and Irrigation of the Ministry of Agriculture has also expressed her intention to widely introduce and utilize drones as an ICT technology.

3-2-2. Implementation of ToT Training

1. Objective

ToT was conducted for the Agricultural Machinery TG. The training period was from Monday, May 23 to Friday, May 27, 2022. During the period leading up to the training, discussions were held with the TG leaders, and coordination work was conducted in the Mombo Irrigation District (Figure 3-3), where the training was held. The training was divided into three themes (Land preparation, Harvesting, and Post harvesting), and lectures and practical training were conducted on each theme. The training consisted of classroom lectures at a meeting facility in IS office located near the city (1), practical training on land preparation at an irrigated rice cultivation area (2), practical training on harvesting at a field south of the irrigation area (3), and training on rice milling facilities at a rice mill located north of the irrigation area (4). A total of 10 participants from KATC, MATI, and the Ministry of Agriculture of Zanzibar, who belong to the Agricultural Machinery TG, participated in this ToT.

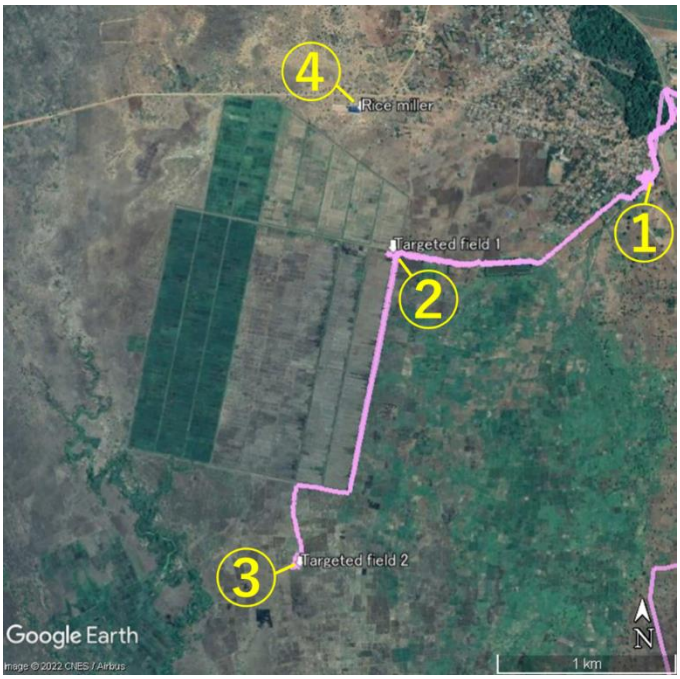


Figure 3- 3. Location of the traial ToT on Agricultural Machinery

2. Contents

The training was divided into three themes (Land preparation, Harvesting, and Post harvesting), and lectures and practical training were conducted on each theme. Since specific agricultural machinery was used for harvesting and post-harvest processing, technicians from Agricom and Rubye Agri Business were invited for harvesting and post-harvest processing, respectively, to share specialized machine-specific skills.

As for the actual machinery used, a power tiller made by a Chinese manufacturer was used for land preparation, a Kubota DC-70 combine harvester was used for harvesting, and a rice milling unit made by a Chinese manufacturer (mainly having the functions of rough sorting, husking and milling, polishing, and broken rice removal) was used for post-harvest processing.

The training was conducted mainly in Swahili, and the training was recorded on video using a headset-type camera. In particular, the outdoor explanation and operation of the combine harvester were filmed from the technician's point of view, which was shared with the participants as supplementary materials for review.

As an addition to this training, several techniques not included in the existing manual were introduced. Specifically, in the area of land preparation, digital mapping using a drone and the use of field irregularity information were introduced as a trial test of ICT technology, and in the area of post-harvest processing, the quality analysis method for milled rice was introduced based on the expert's experience in other countries. In the post-harvest processing, he also gave advice on not only the use of machines but also how to evaluate operation and maintenance management by analyzing milling yield, pricing by quality, middle man distribution, and other factors from a marketing perspective..

These lectures were well received by the participants, and requests for additional lectures and manuals were made. As for the quality analysis method, since it is possible with small black and white plastic plates, and an electronic balance for quality check, we extended the time on the day of post-harvest processing to allow participants to practice on their own, and attempted to generate data on the broken rice rate after the broken rice

was sorted.

As a supplementary note, since a license is required for aerial drone photography in Tanzania, in this time a licensed drone technician was invited to take aerial drone photography. This time, digital map information (orthoimage and DSM: digital surface model) was created for a 100 ha area, and the expert set up the program to fly and work on the PC. The drone technician edited a 2-minute video introducing the harvest training as a deliverable during the training, which was also shared with the participants.

MATI-Igurusi is planning to introduce GIS and remote sensing (RS) technology for irrigation in future lectures, and has asked for cooperation in reviewing lecture content.

Mombo IS training site

Power Tiller training

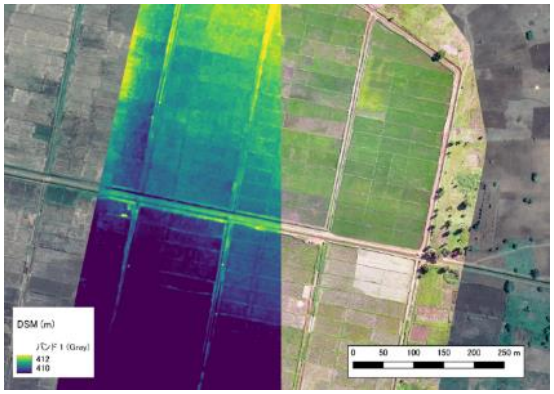
Combine harvester lecture

Combine harvester practical training

Practical training at rice milling facility

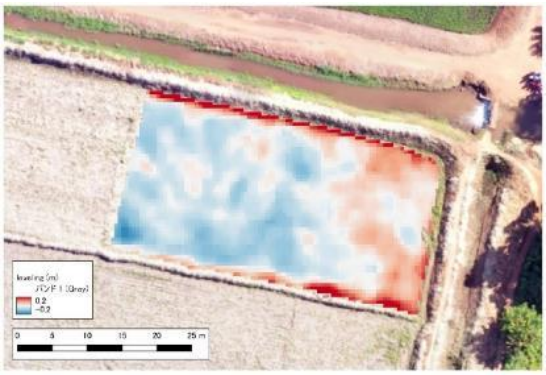
Training of quality analysis of milled rice

Introduction of drone usage



Example of an image created (height information in the left half)

Introduction of appropriate harvesting method



Result of creating land undulation information

Figure 3- 4. Photos of Agricultural Machinery ToT training

3-2-3. Implementation of farmer training

1. Details of the training

Farmer training was conducted at Mombo IS from August 29 to September 2 as a trial training program led by the Agricultural Machinery TG in this activity, as follows.

1) Training participants:

5 irrigation schemes (Kivulini (Mwanga District, Kilimanjaro Region), Musa Mwinjanga (Hai District, Kilimanjaro Region), Lekitatu (Meru District, Arusha Region), Muungano (Babati District, Manyara Region), and Bagamoyo (Bagamoyo District, Pwani Region), respectively. Four operators of power tillers, combine harvesters, and rice mills from Babati District, Manyara Region, and Bagamoyo District, Pwani Region, respectively, bringing the total number of participants to 20. Two operators from Mombo Irrigation District also participated in the training on the combine harvester.

2) Content:

The training consisted of lectures, practical training, and wrap-up sessions on each of the three topics: (1) Land preparation, (2) Harvesting, and (3) Post-harvesting. The lectures were mainly given by agricultural machinery TGs (KATC and MATI (Igurusi, Mlingano, and Mtele)), and the practical training in land preparation and post-harvest handling was provided by outside instructors as technical assistants. The order of field use was

harvest, post-harvest treatment, and land preparation.

The training materials were basically the same as those used for the ToT, and were prepared by TG. The content of the training consisted of lectures, practical training, and wrap-up sessions on each of the three topics: (1) Land preparation, (2) Harvesting, and (3) Post-harvesting. The lectures were mainly given by Agricultural Machinery TG and others, while outside instructors participated as technical assistants in the practical training on land preparation and post-harvest processing. The order of field use was harvesting, post-harvesting, and land preparation.

Lecture by agricultural machinery TG

Practical training on combine harvester

Practical training on quality analysis

Practical training at the rice milling facility

Explanation of income and expenditure calculation

Example of 3D data created in the trial introduction

Figure 3- 5. Photos of Agricultural Machinery Farmer Training

3-2-4. Revision of Training Materials

1. Training materials (guidelines, etc.)

1) In this ToT, additional items were introduced as additional technical knowledge not included in the existing manuals. Specifically, in land leveling, the creation of digital maps by drone and the use of land surface irregularity information was introduced as an attempt of ICT technology.

2) In post harvesting, a method of analyzing rice quality was introduced based on the expert's experience in other countries.

3) In post harvesting, advice was given on the evaluation of rice milling machines and their management and maintenance from a marketing perspective, analyzing not only the use of machines, but also the yield of milled rice, pricing according to quality, and distribution partners of middlemen.

4) In addition, in order to establish training methods in TANRICE 3, issues related to training methods and training materials were identified and suggestions for improvement were discussed.

5) Based on the contents of the ToT and this training, the following issues were extracted, training methods and training materials were identified: 1) Understanding and analyzing methods related to rice quality, 2) Understanding and basic estimation methods related to operation and maintenance (O&M) of agricultural machinery, and 3) Application of drones in rice cultivation, which can be added as new contents related to the above ICT survey and trial introduction test. This can be added as new content. Draft training materials were prepared.

2. Contents, items, etc.

1) Regarding the training system, there are training materials (manuals) written in English and Swahili, but they are not sufficient for participants to understand each process of farm machinery operation.

2) Regarding the training method and schedule, the number of words in the materials distributed on the day of the training should be reduced to increase the number of charts and diagrams, and the number of days of practical training for skills and calculations should be increased. It would be effective to devise ways to deepen participants' understanding by dividing them into classes according to the type and size of their farmland and their abilities.

3-3. Irrigation Scheme Management

3-3-1. Existing Materials and Training

The basis of the current Subject Matter Training on irrigation scheme management was developed in the Kilimanjaro Agricultural Technician Training Center Project Phase 1 (KATC 1: July 1994 to June 2001) as the irrigation scheme management training. It was taken over by Phase 2 (KATC 2: October 2001 to September 2006), but at that time the training was based at KATC and focused on technology to compensate for the weaknesses of farmer organizations in irrigation scheme management.

TANRICE 1, which was conducted from 2007 to 2012, stated that it is possible for farmer organizations to operate and maintain irrigation facility systems, which are the foundation of irrigation project areas, with proper guidance from the relevant authorities as well as the efforts of farmer organizations, and in 2009, training

guidelines for farmer organizations were established. The Irrigation Scheme Management course has been conducted from 2010 to the present. The TANRICE 2 conducted in 2013-2019 used a combination of on-site training (about two sites per year) conducted within each MATI's jurisdiction district and a workshop style (10 irrigation schemes per workshop) where several districts were brought together at the KATC. . The number of participants was expanded through a series of trainings at TANRICE 1 and 2 through these trainings. This method made it possible to conduct training in a large number of schemes in a short period of time. In addition, improvements have been made to the monitoring sheet (profile sheet), which enables numerical measurement of training effectiveness, making it possible to conduct detailed and individualized monitoring.

The training has contributed not only to the improvement of the operational capacity of each scheme, but also to the improvement of the training capacity of the tutors of each MATI. It is expected that TANRICE 3 will be able to make use of this training program for more efficient training.

On the other hand, it was found that the monitoring sheets were not being fully utilized. As a result of the discussion, it was decided that the TG leader would call the leaders of farmers' organizations in each irrigation scheme twice a year to urge and instruct them to fill in the monitoring sheets and submit them to the DALDO office. It is necessary to ensure that TANRICE 3 follows up on the monitoring sheets to objectively understand changes in the scheme.

NIRC and the Irrigation Department of Zanzibar were also invited to the ToT this time to exchange information and views from the perspective of irrigation scheme management. The TG members' knowledge and the quality of the revised guideline (ver.6) have been improved by the unification of the latest trends of irrigation project, new official procedures, and the use of terms and phrases that had the same meaning but were expressed in different terms in each organization. It is expected that other relevant organizations will be invited to the TARICE3 ToT training sessions as much as possible, and that activities will be undertaken to reflect the latest information in the guidelines through the exchange of opinions. These activities will lead to the dissemination of the guideline to all parties concerned in the future.

3-3-2. Implementation of ToT Training

1. Objective and content

1） To review the implementation guidelines for SMT-ISM.
2） To discuss and review the criteria for selecting irrigation schemes for inclusion in the SMT-ISM.
3） To enhance the understanding of participants, especially new TG members, through training and discussion on the SMT-ISM concept and SMT-ISM implementation methods.
4） Planning and preparation of TG members for future SMT-ISM training.
5） Place of implementation: MATI-Ilonga
6） Date and time of implementation: Monday, July 11 - Thursday, July 14 2022 (4 days)
7） Participants: TG members and weaving irrigation technicians, 17 in total (KATC: 2, MATI-Ilonga: 2, MATI-Igurusi: 2, MATI-Tumbi: 2, MATI-Ukiriguru: 2, MATI-Mtwara: 2, SoA: 2, NIRC Kilimanjaro Reginal office:2, Zanjibar IO:1)
8） Contents:

- Review and discussion of training contents on organization, financial management and O&M using Implementation Guideline for SMT Course on ISM (ver.5) as text (3 days)
- Confirmation and discussion on the use of monitoring sheets and follow-up methods (1 day)

2. Results

1） Implementation Guidelines for SMT-ISM including monitoring ver. 6 were developed. It has changed from the existing implementation guidelines ver.5, including changes in terminology and increased costs due to the reorganisation of government structures, but the basic methods and contents remained the same.

2） Although there were 3 participants who were not TG members and 3 new TG members, which resulted in 6 out of 17 participants who were new to conducting ISM training, the objectives of this ToT training were achieved, led by the new TG Leader, and the next planned farmer training was well organized.

3） NIRC and the Irrigation Department of Zanzibar also participated in the training, and a cooperative relationship was established with TG group.

3-3-3. Implementation of Farmer Training

1. Contents of the training conducted

1） Objective: To mentor farmer associations and cooperatives (IOs) and strengthen their capacity to manage their schemes. To strengthen their capacity to operate and manage irrigation project sites in the areas of mentoring, finance, and operation and maintenance (O&M).

2） Venue: Idodi irrigation project site, Iringa Rural District

3） Timing and number of days: Tuesday, September 6 to Friday, September 9 (4 days)

4） Participants: TG members, 40 farmers (including 10 leaders) from selected areas (districts), some district government officials, about 50 people maximum

5） Contents: Implemented by TG members based on the guideline ver.6

- Basic survey on the condition of irrigation facilities and farmers' organizations (1 day)
- General introduction to good water use organizations (1 day)
- Identification of problems (1 day)
- Guidance on "Action Plan Development (1 day)" according to the guidelines

2. Results

The training was conducted smoothly in accordance with the training content of the guidelines, although it did not run to the time originally planned due to the breakdown of the bus travelling to the site due to the breakdown of the bus traveling to the site. As a result, the TG members' evaluation was that the attitude of the farmers (especially the executives) had clearly changed. Furthermore, they also reaffirmed the importance of carefully listening to farmers' opinions and preparing training programs in accordance with the guidelines.

3-3-4. Revision of Training Materials

1. Points and reasons for revision (modification) of each material

TANRICE 3 will use the Implementation Guidelines ver. 6 to conduct farmer training. In the future, the basic concept will not need to be changed significantly, but constant attention should be paid to changes in the terminology used within the guidelines and the cost of training. In the field, officials in the Regions requested that allowances be improved based on the government-recommended allowances for administrative officers; in TANRICE 2.5, the old unit costs were used; in TANRICE 3, DSA and others will have to adopt the new unit costs. Agreement on budget execution needs to be reached with the Tanzanian side at the start of the project. 3.

2. Other

1） Review of these guidelines with NIRC and Zanzibar Irrigation Department officials revealed that these guidelines will contribute to improving the lack of capacity of district irrigation officers, who are the technical backstop of irrigation schemes, as pointed out in TANRICE 2.

2） When selecting training targets, the training effect would be more visible if the training is focused on areas where irrigation facilities are well equipped, but there have been few schemes with well-equipped irrigation facilities, and many of the schemes are in a situation where irrigation facilities cannot function properly as a foundation for irrigated rice cultivation due to poor design and construction, poor maintenance, flooding, etc. Therefore, in Tan Rice 3, it is expected to develop training materials and programme construction based on the current materials, in cooperation with NIRC and ATC on the technical aspects of the facilities for the operation of the project in order to enable irrigated rice cultivation even in situations where irrigation facilities are inadequate. Therefore, it is expected to develop training materials and programs based on the current materials, including technical aspects of the facilities in cooperation with NIRC, ATC, and JIRCAS, and issues of financing in case large-scale rehabilitation is required so that the training can be effective in concrete ways after the training.

3） To tackle the replacement of leaders and the presence of leaders who do not faithfully fulfil their role as leaders. It is expected that the training will be repeated not just once, but regularly, and that follow-up will be conducted after the training to monitor the changes in sites and create a mechanism for the concept of ISM training to firmly settle in the farmers in the sites. Measures to deal with the change in leadership and the existence of leaders who do not faithfully fulfill their roles as leaders. It is expected that the training should be repeated not only once, but regularly, and that follow-up after the training should be conducted to identify changes in the scheme, and to establish a mechanism to embed the concept of ISM training in the farmers in the scheme.

3-4. Marketing

3-4-1. Existing Materials and Training

Among the 4 items of the TANRICE 2 marketing training (quality assurance, market information, record keeping and accounting, and sales agreement), for "quality assurance," activities such as seed renewal and paddy cleaning were well adopted in many areas, supported by the fact that the effects are easily reflected in sales

prices. In the interviews with farmers, the next most highly rated activity was "record keeping and accounting". As for "sales agreement," although some farmers in Bagamoyo IS had agreements with middlepersons, overall, many farmers felt that the implementation of such agreements was too difficult because it is necessary to negotiate with the middlepersons in advance, and it is necessary to collect the opinions of the farmers in advance. It should be noted that "sales agreements" were "highly adopted" in the report of the TANRICE 2 chief advisor, and in the final report, "have also had a positive impact on rice sales". It is possible that the assessment has changed over time.

As for "market information," no farmers specifically mentioned it, partly because information gathering via cell phones has become commonplace.

TANRICE's subject matter training in the marketing area consisted of a 1- to 4-day training program in which tutors selected a combination of five themes: study tour of processors/markets (which was deleted when the TANRICE 2 guidelines were revised), market information, record keeping and accounting, sales agreements, and quality assurance. The themes were basically designed to increase farmers' profits by strengthening their information gathering and negotiation skills.

During the discussion on the implementation of the ToT, the TG members strongly requested the revival of the "study tour of processors/markets". The reason given was that it was a very effective activity in motivating the participants for subsequent activities. Certainly, "visits to processors/markets" is the only field activity in marketing training, which tends to involve a lot of classroom learning, and exchanging opinions with people who actually buy one's own produce is a good stimulus. The "visits to processors/markets" are effective as an activity to promote farmers' "awareness," which is emphasized in the SHEP approach. Although TANRICE 2 seems to have required the deletion of one of the items from the viewpoint of reducing implementation costs, we still do not see the need to delete the item since the number of training days can be adjusted from 1 to 4 days by selecting and combining the items.

On the other hand, both farmers and TG members were negative about "Collective Marketing," which was identified in the final report of TANRICE 2 as an area where technical assistance is needed in the next phase. Although they understand the importance of this issue, there seems to be a strong psychological aversion to it, as the experience of failed cooperative farms under the post-independence Ujamaa policy persists in the farmers' consciousness. Nevertheless, strengthening market bargaining power is often limited to individuals, and in the future it will be necessary to aim for joint sales in groups or cooperatives. Since it is considered effective to demonstrate successful cases within Tanzania, it is necessary to collect successful cases and extract success factors, etc.

In addition, strengthening access to financial services, etc. were mentioned as additional items, but the final conclusion will be determined based on the results of the ToT and farmer training.

3-4-2. Implementation of ToT

The ToT in the area of marketing was originally scheduled for late July, but was rescheduled for late August due to renovation work at the venue and the implementation of the national census.

Schedule of ToT (Marketing)

Date and Time	Programme	Remarks
August 29 (Mon.)		
9:00-9:30	Registration, Opening remarks, Introduction of participants, Adaption of schedule, etc.	
9:30-10:00	Review of structure of subject matter training on Marketing	Introduction by TG leader
10:00-11:30	Lecture Review 1: Record Keeping	Trial lecture by Peter A. Kabelelo (KATC), discussion, guidance to new members
11:30-13:00	Lecture Review 2: Quality Assurance	By Salma Yahya (SoA, Zanzibar)
13:00-14:00	Lunch	
14:00-15:30	Lecture Review 3: Market Information sharing	By Georgina C. Philipo (MATI-Igurusi)
15:30-16:00	Summing up of the day	
August 30 (Tue.)		
9:00-9:30	Registration, Adaption of schedule of the day, etc.	
9:30-12:30	Lecture Review 4: Sales Agreement	By Doroth R. Mushi (MATI-Mtwara)
12:30-13:30	Lunch	
13:30-15:30	Lecture Review 5: Study tour and its evaluation	By Winza A. Nzaga (MATI-Ukiriguru
15:30-16:00	Summing up of the day	
August 31 (Wed.)		
9:00-9:30	Registration, Adaption of schedule of the day, etc.	
9:30-12:00	Discussion: new contents -Collective marketing (Joint sales) -Financial access	Detailed contents to be decided
12:00-13:00	Lunch	
13:00-15:30	Discussion: Revise of guidelines and material	
15:30-16:00	Summing up of the day	
September 1 (Thu.)		
9:00-9:30	Registration, Adaption of schedule of the day, etc.	
9:30-12:00	Discussion: Trial Farmers Training (Trial in-field training) When, where, on what contents.	
12:00-12:30	Closing	

The following activities were mainly conducted during the training.

1. Lectures on and improvement of 5 basic topics (study tour of processors/markets, market information, accounting records, agreement on terms and conditions of trade, quality assurance)

2. Discussion on improving training materials (sample format for accounting records, training materials on yellow colored rice, update on how to obtain market information, etc.)

3. Consultation on additional components

- Collective marketing: use one day to provide guidance on the benefits of Collective marketing, establish a marketing committee, determine sales locations, etc. Conducted the day before the "Agreeing on Terms of Sale" theme to encourage trading to take place through Collective marketing.
- Strengthening Access to Finance: Consists of 3 types of activities: financial management and budgeting, guidance in developing a business plan, and inviting neighborhood financial organizations to create links. It fits in well with the theme of 'accounting records'.

4. Revised marketing guidelines

- Study Tour was revived and two new items were added, and the order of implementation was rearranged based on compatibility between themes.

DAY 1	Study Tour of processors and Markets
DAY 2	Quality Assurance
	Market Information Accessing and Sharing
	Financial Access
DAY 3	Record Keeping
DAY 4	**Collective marketing**
DAY 5	Formulating Sales Agreement through Stakeholders Meeting

*Bold underlines indicate new components; underlines only indicate old components that have been restored.

- Change in IS selection criteria for training

  One of the IS selection criteria, "functioning SACCO" was changed to "has an active irrigation group". This is because functioning SACCOs are now rare. In addition, the participant quota that had been allocated to SACCOs was expanded to "neighboring financial institutions".

- How to Conduct Monitoring Activities (reconsideration required)

  The original proposal was for a telephone survey, but 2 days of on-site monitoring was proposed and a draft monitoring questionnaire sheet was developed. However, in TANRICE 2, the monitoring budget is borne by the Tanzanian government (district government), and if this system continues in TANRICE 3, a realistic monitoring method needs to be considered.

5. Determine venues and dates for marketing farmer training

Of the 4 MATIs with new members, MATI-Ilonga (Morogoro Region) was selected because of its proximity to a suitable IS for farmer training (Mkindo IS, Mvomero District, about 1 hour from MATI-Ilonga). Implementation will take place between October and November, to be determined in coordination with the Regional Training and Gender Farmer Training.

The training will be conducted for 5 days in accordance with the proposed revision of the guidelines mentioned above. However, the fourth day, "collective marketing," may be removed because it is too large a theme to be implemented in a single day and would be too much work for the team, mainly consisting of new members.

6. Others

- August 30 (Day 2 of the Marketing ToT): Greetings by Assistant Director (Dr. Mdangi), Training and Research Department, MoA.
- Sept. 1 (Day 4 of Marketing ToT) Greetings by Director (Dr. Mafuru), Training and Research Department, MoA. He shared with the participants that TANRICE 3 had been discussed the previous day and a minute

agreement was reached.

Figure 3- 6. Photos of Marketing ToT

3-4-3. Implementation of Farmer Training

1. Venue: Mkindo Irrigation Scheme, Mvomero District and Morogoro Region
2. Schedule: October 17-21, 5 days
3. 4 lecturers: 2 MATI-Ilonga, TG Leader and Sub-leader 4.
4. Participants: 2 MATI-Ilonga, TG Leader and Sub-leader

	Day 1	Day 2	Day 3	Day 4	Day 5
Farmers	20	17	17	13	18
Extension Officers	2	2	2	2	2
Rice Middlepersons	-	-	-	-	6

5. Schedule

October 16 (Sun)	Meeting with lecturers, visit to rice millers in Dumilla (Study Tour)
October 17 (Mon) DAY 1	Courtesy visit to DAICO Study Tour of processors (Visit 3 rice millers in Dumilla)
October 18 (Tue) DAY 2	Quality Assurance
	Market Information Accessing and Sharing
October 19 (Wed) DAY 3	Record Keeping **Financial Access**
October 20 (Thu) DAY 4	**Collective Marketing**
October 21 (Fri) DAY 5	Formulating Sales Agreement through Stakeholders Meeting

Bolded text indicates new components.

- The itinerary adjusted for the ToT training was partially modified (limited to 2 items per day).
- Study tour (inspection of rice mills) was conducted on the second day to increase farmers' motivation for

"Quality Assurance" and "Market Information Accessing and Sharing". The study tour was very effective in motivating farmers for "Quality Assurance" and "Market Information Accessing and Sharing" on the second day.

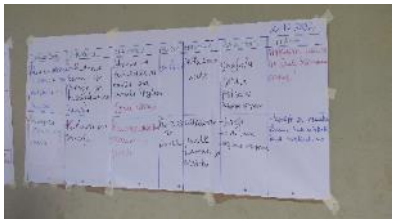
- Stakeholder meetings with middlepersons confirmed that there were consensual reasons for the practices of middlepersons that were viewed critically by farmers (e.g., not using scales, taking too many samples, etc.). At the same time, it was confirmed that there are advantages for both farmers and traders in collecting and trading rice in one place, resulting in increased interest in collective marketing.
- Materials for new training items were developed and existing items were revised.

Observation of rice millers

Lecture

Group discussion

Training venue



Action plan for collective marketing

Stakeholder meeting with middleperson

Figure 3- 7. Photos of Marketing farmer training

3-4-4. Revision of training materials

1. Training materials (guidelines, etc.)

1) Revision of guidelines

The TG discussed the possibility of adopting a field monitoring system since telephone monitoring has not been working effectively. However, further discussion is needed on securing financial resources for on-site monitoring.

One of the criteria for selecting ISs for training, "functioning SACCOs," was changed to "active irrigation organizations" on the grounds that functioning SACCOs have been rare in recent years, and accordingly, the scope of participants was expanded to include local financial institutions other than SACCOs.

The training schedule was also revised to maximize training effectiveness through synergies. The schedule was adjusted so that Study tour was conducted on the first day, "Quality Assurance" on the following day, and "Accounting Records" and "Financial Access" on the same day. In addition, materials for new items and a draft questionnaire form for on-site monitoring were prepared.

2. Content, items, etc.

In the TANRICE 2 guidelines, "Study tour (visit to local markets and rice mills)" was deleted due to budget

cuts, but the TG decided to reinstate it. The study tour should be conducted at the beginning of the training so that participants can learn how their rice is evaluated by buyers. This experience will help participants identify which aspects of their marketing skills need to be improved or strengthened.

Two new items, " collective marketing" and "access to finance," have also been added. The final report of TANRICE 2 had already recommended the addition of "collective marketing" as a factor to enhance farmers' bargaining power. In addition, "Access to Finance" was added because although financial aspects are important in rice marketing, the existing training items did not include a section dealing with finance.

3-5. Gender

3-5-1. Existing Materials and Training

All 14 members of the Gender TG remained from TANRICE 2, and no additions or changes of members were necessary. Members were nominated by faculty members teaching extension, nutrition, gender, and other classes at each MATI. However, four of them had no experience in conducting TANRICE trainings, as they joined at the end of TANRICE 2.

Since the end of TANRICE 2 in 2018, no TANRICE trainings have been conducted voluntarily, but trainings have been conducted for farmers on one-off themes (e.g. gender, food processing, etc.) at the request of NGOs (Lutheran Relief, Swiss Contact, etc.).

The inadequacy of the monitoring activities pointed out in the final report of TANRICE 2 was due to the budget for implementation; in TANRICE 1, the monitoring was project budgeted, but from TANRICE 2, it is now district budgeted. However, the budget allocation was not properly allocated; for example, MATI-Ilonga had only one monitoring conducted during TANRICE 2.

The gender sector training for TANRICE 2 was conducted over a total of five days, with one day each for the four themes of gender sensitization, household management, HIV/AIDS, and nutrition and sanitation, after the needs identification survey on the first day to identify priority items. During the field survey in March 2022, TG members were asked which items were important to them, and they all agreed that "household management" was relatively important, but the priorities of the other items were varied.

Although this issue-based training program is labeled as a gender training program, it actually covers a wide range of topics related to "improving livelihoods" in general. Since people's interests and concerns about life in general differ greatly, it is inevitable that people's evaluations of items in the gender sector differ from person to person.

It may be more effective to increase, rather than decrease, the number of items in gender training, and to create a system in which items are tailored to the interests and problems of the target audience.

At this point, the candidates for additional items are: how to cook rice with high nutritional value, value-added activities to improve women's income, etc.

3-5-2. ToT Training

The ToT in the gender area was scheduled to be held at MATI-Mwanza in early August, but due to the facility renovation work, the request from JICA Tanzania office to change the venue, and the population census,

the ToT was finally conducted from September 5 to 8, 2022 with the following contents.

ToT Schedule (Gender)

Date and Time	Programme	Remarks
September 5 (Mon.)		
9:00-9:30	Registration, Opening remarks, Introduction of participants, Adaption of schedule, etc.	Principal MATI-Ilonga, Mr. Felix
9:30-10:00	Review of structure of subject matter training on Gender	Introduction by TG leader Mr. Amoni Mtono
10:00-11:30	Lecture Review 1: Gender Sensitization	Trial lecture by Ms. Upend（KATC） &Ms. Renatha (Ukiriguru) and discussion
11:30-13:00	Lecture Review 2: Family Budgeting	Trial lecture by （Igurusi）Mr. Chilewa and discussion
13:00-14:00	Lunch	
14:00-15:30	Lecture Review 3: Gender and HIV/AIDS	Trial lecture by experienced member and discussion
15:30-16:00	Summing up of the day	
September 6 (Tue.)		
9:00-9:30	Registration, Adaption of schedule of the day, etc.	
9:30-11:00	Lecture Review 4: Nutrition and Sanitation	Trial lecture by experienced member and discussion
11:00-12:30	Lecture Review 5: Approach for Needs Finding Survey (Baseline survey), Monitoring and Evaluation of the action plan.	
12:30-13:30	Lunch	
13:30-15:30	Discussion 1: new contents - women involvement in value addition - gender-based –violence - nutrition connected with promotion of rice production like brown rice and other vegetables.	
15:30-16:00	Summing up of the day	
September 7(Wed.)		
9 :00- 9 :30	Registration, Adaption of schedule of the day, etc.	
9 :30-12:00	Discussion 1: new contents (Continue)	
12:00-13:00	Lunch	
14:00-16:00	Discussion 2: Revise of guidelines and material	
15:30-16:00	Summing up of the day	
September 8 (Thu.)		
9:00-9:30	Registration, Adaption of schedule of the day, etc.	
9:30-12:00	Discussion 3: Trial Farmers Training (Trial in-field training) When, where, on what contents.	
12:00-12:30	Closing	

The following activities were mainly conducted during the training

1. Lecture exercises on 5 basic themes (needs assessment, gender sensitization, household financial management, HIV/AIDS, nutrition and sanitation)

Methods of implementation and content of training materials for the existing themes were reviewed. The visual aids (posters) are well prepared, but there are no instructions on how to use the materials (how to explain), which makes it difficult for new members to handle them. We confirmed how to handle the training materials among the members. In addition, some exercises (exercises) are missing in the joint management of household finances,

and we are considering adding them. 2.

2. Discussion on additional components

- Rice value addition (Rice value addition):

The first proposal was "value addition activities by women," but the name was changed as it was not appropriate to limit it to women from a gender perspective.

The use of rice flour was discussed, and finally three remained: shiratama (white rice balls), rice porridge, and rice-flour bread (adopting the 100% rice-flour recipe used in Tanzania). The shiratama was tasted using Japanese shiratama flour, which is popular for its ease of preparation, but may not be sticky enough for Tanzanian rice flour After the ToT, each MATI will conduct a trial production and the results will be used to decide which recipe to adopt for the farmer training.

- Gender based violence:

“Gender sensitization" was to be addressed as part of the theme. A simple quiz or exercise will be used to raise awareness.

3. Revision of Gender Guidelines

The schedule remained basically the same, but new themes were incorporated into the basic schedule. However, since there will be a cooking class on the last day, there is a proposal to incorporate the "Sanitation" part of the last day into the fourth day.

Day1	Baseline Survey (needs identification survey)
Day2	Gender sensitization + GBV (gender-based violence)
Day3	Family Budgeting
Day4	HIV/AID
Day5	Sanitation and Nutrition and Rice Value addition Due to time constraints, there is a proposal to incorporate sanitation into Day4.

In addition, a budget table and a breakdown of participating farmers (Key farmers, Intermediate farmers, Ordinary farmers) were added so that the estimated cost of the training can be confirmed.

Monitoring was controversial, as was the marketing ToT. Currently, the method is to have the VAEO or DAICO in charge of the target area collect information, but if they are not responsive, a simpler method needs to be considered.

In addition, one page is devoted to capacity building activities for TG members (training for new members, participation in training in Japan, etc.), and the description of this section needs to be adjusted in light of the activities in TANRICE 3.

4. Decision on venue and schedule of training for gender farmers

All 14 TG members are existing members from TANRICE 2, but 4 of them joined at the end of TANRICE

2 and have no experience in conducting farmer training. Of the MATI to which these four members belong, MATI-Ukiriguru was selected because of the presence of a nearby IS (Mariwanda IS, Bunda Region) for training.

Figure 3- 8. Photos of Gender ToT

3-5-3. Implementation of Farmer Training

1. Venue: Mariwanda Irrigation Scheme, Bunda District, Mara Region)
2. Instructors: 2 MATI-Ukiriguru, TG Leader and Sub-leader
3. Participants:

	Day 1	Day 2	Day 3	Day 4
Farmers	34	28	28	32
Extension officers	2	2	2	2

4. Schedule

October 8 (Sat)	Trial cooking of new recipes
October 9 (Sun)	Meeting with lecturers, travel to Bunda District
October 10 (Mon) DAY 0	Courtesy visit to DAICO, Bunda Baseline Survey -visit and interview to farmers, clinic, Scheme leaders, etc.
October 11 (Tue) DAY 1	Gender sensitization＋**Gender based Violence**
October 12 (Wed) DAY 2	Family Budgeting
October 13 (Thu) DAY 3	HIV/AID, Sanitation

October 14 (Fri) DAY 4	Nutrition & cooking demonstration of vegetables **Rice Value addition (Rice flour utilization)**: Cooking demonstration of Rice bread, Rice ball (Shiratama) and rice porridge

*Bolded words indicate new components.

- The schedule was based on the one determined in the ToT conducted in September. No major problems were found other than time allocation.
- As part of the "Rice Value addition," three recipes using rice flour were tested. Of the rice flour bread, white rice balls, and rice porridge, rice porridge was the most popular. The reason was that it was easy to prepare and the profit from sales was easy to calculate.
- Guidelines and training materials will be fine-tuned to reflect the results of this training.

Baseline Survey

Gender Lecture

Exercise: Family budgeting

Interviews with clinics

Cooking practice 1

Cooking practice 2

Figure 3- 9. Photos of Gender farmer training (October 8-14)

3-5-4. Revision of training materials

1. Training materials (guidelines, etc.)

(1) Revision of guidelines

Materials were prepared for new topics and content. Since a wealth of materials were originally prepared by TANRICE 2, the revision of existing materials was limited to minor changes.

The TG suggested conducting regular training sessions especially for new trainers to learn how to conduct effective and efficient training and how to use the materials appropriately. 2.

2. Content, items, etc.

In order to strengthen farmers' sources of income from rice, a new content item "Value Added of Rice" was added. TG introduced new rice recipes such as white rice balls, rice porridge, and rice bread. By selling processed products, farmers can generate more income than by selling paddy or grain. Cooking classes were conducted in one of the content areas, "Nutrition," so the new recipes were demonstrated at this time as well.

Since "gender-based violence" still has a serious impact on farmers' lives, it was introduced as a new theme in the existing content "Gender Awareness."

The TG also discussed changes to the monitoring system: in TANRICE 2, training monitoring was not properly implemented due to lack of budget and non-cooperative attitude of extension officers. However, discussions in the TG failed to generate ideas for a realistic and effective monitoring approach.

4. CARD-Regional Training

4-1. Training Overview and Results of TANRICE 2

As a result of many years of JICA technical cooperation in KATC/MATIs in Tanzania, rice technology training consists of three general training courses on rice cultivation ("Irrigated Rice Cultivation," "Rainfed Lowland Rice Cultivation," and "Rainfed Rice Cultivation") and four Subject Matter Training courses ("Irrigation Scheme Management," "Marketing," "Gender," and "Agricultural Machinery Training"). The basic concept of the program is to "increase rice yields through more precise and timely intervention. For small-scale farmers with few resources, the most readily available resource is family labor, and it is important to use it effectively. In addition, in order to disseminate rice cultivation technologies nationwide, instead of training mainly technicians in irrigation scheme areas as in past, the key farmers in the irrigation scheme areas were given direct training to the farmers targeted for training ('farmer-to-farmer extension' approach), which contributed to increased rice production in the country.

Table 4- 1. Technology Exchange Programs Implemented in the past

List of Technical Exchange Program hosted by TANRICE2

Nov 2012 - Nov 2018

	Visitors country	Project name	Number of visitors	Schedule	Venue	Number of participant from Tanrice2	TG in charge
2012-2014							
N/A							
2015							
1	Rwanda/Burundi/ Uganda	(JICA Rwanda Office)	6	Nov 29 - Dec 4, 2015	KATC	15	ISM
2016							
2	Kenya	Rice-based and Market-oriented Agriculture Promotion Project (RiceMAPP)	14	Feb 1-5, 2016	KATC	74	E&M
3	Kenya	Project on Enhancing Gender Responsive Extension Services in Kenya (PEGRES)	16	Nov 7-12, 2016	KATC	20	Gender
2017							
4	Burundi	The Project for Supporting the Improvement of Rice Farming in Republic of Burundi	15	Sep 3-10, 2017	KATC	15	-
5	Egypt/Rwanda/ Uganda/Ethiopia	Follow-up Workshop on Rice Cultivation Techniques in Africa	16	Dec 4-9, 2017	KATC	17	-
2018							
6	Mozambique	Project for Improvement of Rice Production in Zambezia Province (ProAPA)	8	Mar 5-11, 2018	KATC	17	RA
7	Ethiopia	Project for Functional Enhancement of National Rice Research and Training Center (Ethio-Rice)	9	(Aug 14-18, 2018)	KATC	(20)	RA
Total	**7 countries**	**7 groups**	**84**				

The " Standard training " consists of (1) baseline survey, (2) residential training at KATC, (3) field training in various locations, and (4) post-harvest monitoring, except for the training for "Rainfed rice cultivation," and is a 16-day program for "irrigated rice cultivation" and a 9-day program for "Rainfed lowland rice cultivation. The training focuses on the production part of rice cultivation activities, with participants repeatedly learning the necessary processes and practicing the acquired knowledge and skills in the field. Due to this feature, the techniques learned in the training are not complicated, but easy and simple, and the trained farmers (key

farmers) were able to continue to use the same techniques. In addition, because the training consisted of group training and on-site training, the key farmers were able to practice what they learned in the field, and the intermediate farmers and other farmers were also able to acquire the skills. Moreover, irrigated rice cultivation requires not only the dissemination of individual cultivation techniques, but also organized systematic activities for the entire irrigation scheme. Strengthening such organized activities of farmers is difficult to achieve only through training at KATC, and this was realized through activities at the field training sessions at the site.

The above-mentioned 7 Technical Exchange (TEx) programs were held to share and exchange views on the implementation, effectiveness, challenges, the contents of research and improvements of the training programs related to rice promotion. These activities enhanced the knowledge of rice cultivation among the parties involved.

4-2. Training that can be conducted in Tanzania (KATC) and can be useful in other countries

- Irrigated Rice Cultivation (rice growing districts where irrigation facilities exist)
- Rainfed Lowland Rice Cultivation (rice areas without irrigation facilities)
- Training on management of rice production areas in Subject Matter Training (in particular, Irrigated Scheme Management: long experience in training along with rice cultivation technology, it contributing to self-sustaining development activities in rice production areas; Gender: results of TG activities, achievements and challenges were presented at the New York UN headquarters in March 2018, it contributing to self-sustaining development activities in rice production areas).

4-3. Regional Training in TANRICE 2.5

4-3-1. Training Implementation Process

The preparation period before the training is particularly important. It is important to plan the items to be prepared for the implementation in a concrete manner along the time axis.

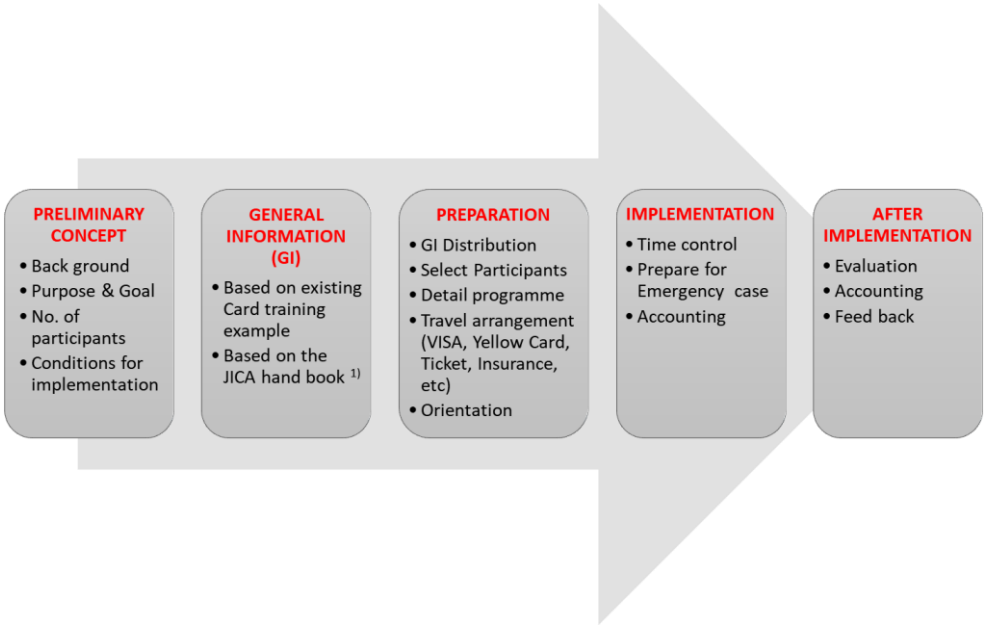


Figure 4- 1. CARD Regional Training implementation process

4-3-2. Implementation Overview

As part of the CARD support, the training content and dissemination methods related to rice cultivation technology that have been conducted at KATC/MATIs in Tanzania, which are considered to be available in other countries, will be shared with other countries.

As TANRICE 3 is planning to support regional training, this study on TANRICE 2.5 will be positioned as a process to verify the feasibility of implementing regional training based on KATC. In the process, KATC will also seek to improve its capacity to conduct regional training.

The outline of the training is as follows

1) Training Title

Rice Cultivation Technology in Tanzania

2) Duration

From October 24 to 29, 2022 (6 days)

3) Inviting countries

CARD members, 5 English-speaking countries near Tanzania: Kenya, Malawi, Rwanda, Uganda, and Zambia

4) Number of participants

3 from each country, 15 participants in total

5) Language

English

6) Course objectives

(1) To share how the participating countries are implementing policies on rice crop extension

(2) To share what kind of technologies are being implemented in Tanzania for rice crop extension

(3) To share what kind of training (content and methods) is being provided to promote rice crop extension throughout the country based on the general training on rice crop at TANRICE

(4) To develop an action plan on rice crop dissemination after returning to their home countries, referring to this training.

7) Overall Goal

Acceleration of rice production in each participant's country.

8) Implementing entities JICA, KATC

TG Leaders (Rice Agronomy, Irrigation Scheme Management, Agricultural Machinery, Marketing, Gender) including the DTR and KATC

Incidentally, the TANRICE 2.5 survey was intended to contribute to stable and quality rice production in Tanzania and smooth and effective implementation of TANRICE 3 by conducting the following activities and collecting necessary information.

- Study the establishment of a comprehensive training system based on an understanding of the current situation.
- Study to strengthen the self-reliance and sustainability of rice cultivation training system

- Establish an efficient cultivation system and increase production by improving rice cultivation techniques (especially Rainfed rice cultivation)
- Study of strengthening of rice cultivation mainly in the East African region by sharing knowledge with neighboring countries
- Additional study on the direction of JICA assistance in the rice cultivation sector in the future.

The Kilimanjaro Agricultural Training Center (KATC) is one of the few institutions under the Ministry of Agriculture that offers specialized short courses in agriculture, with a particular emphasis on improvement of irrigated rice cultivation. The center aims to enhance the technical capacity of field officers and key rice farmers in irrigated rice cultivation area through practical training and field tours. The center is well equipped and consists of qualified and experienced trainers in the fields of irrigated rice cultivation, extension, water management, and rice mechanization.

9) Venue

Kilimanjaro Agricultural Training Center (KATC), Moshi, Tanzania

10) Course Methodology

Lectures, field visits, discussions, and presentations

11) Course Content

The contents of this course are as follows

(1) Presentation of rice extension policies on "irrigated rice cultivation" and "rainfed lowland rice cultivation" in participating countries
(2) Presentation of training cases conducted by KATC/MATIs focusing on "Role of Officials and Farmers
(3) Field visits to two excellent schemes
(4) Discussions with representatives of advanced rice growing schemes in Tanzania, focusing on "the relationship between government and farmers
(5) Preparation of an action plan to further improve rice cultivation in each participant's country

12) Issuance of Certificate of Completion

Certificates will be awarded at the end of the training course for active participation, attendance, submission of assignments, and contributions to the course.

13) Expenses

Travel and daily lodging and training materials for participants from 5 target countries, for 20 representatives of irrigation schemes in Tanzania and for TG members outside of KATC. It is necessary to discuss the possibility of the participating countries/organizations bearing the costs of the training (travel, accommodation, etc.) among the parties concerned in the future.

14) Timetable

Date and Time	Programme	Remarks
October 23 (Sun.)		
	Arriving in Moshi	
October 24 (Mon.)		

7:45	Departing from the hotel to KATC	
8:30	Registration	
9:00-10:00	Opening of the training: Introduction of participants Welcome address of KATC Principal Welcome address of RAA Welcome address of JICA Resident Representative Welcome address of DTR Director Introduction of the training	
10:00-10:30	Break	
10:30-11:30	Introduction of the practice for rice industry development in Tanzania	
11:30-12:30	Presentation of the rice extension practice in Kenya	
12:30-13:30	Lunch	
13:30-14:00	Presentation of the rice extension practice in Malawi	
14:00-14:30	Presentation of the rice extension practice in Zambia	
14:30-15:00	Presentation of the rice extension practice in Uganda	
15:00-15:30	Break	
15:30-16:00	Presentation of the rice extension practice in Rwanda	
16:00-16:30	Wrap up discussion	
October 26 (Tue.)		
7:45	Departing from the hotel to KATC	
8:30-9:00	Introduction of training activities	
9:00-9:30	Chapter 1 RICE CULTIVATION	
9:30-10:00	Chapter 2 FARM DEVELOPMENT	
10:00-10:30	Break	
10:30-11:00	Chapter 3 WATER MANAGEMENT	
11:00-11:30	Chapter 4 EXTENSION FARMER	
11:30-12:00	Chapter 5 SUPPORTING SUBJECTS	
12:00-13:00	Discussion on the activities	
12:30-13:30	Lunch	
13:30-14:00	AFICAT session	
14:00-14:30	Irrigated rice cultivation course	
14:30-15:00	Discussion on the activities	
15:00-15:30	Break	
15:30-16:00	Rainfed lowland rice cultivation course	
16:00-16:30	Discussion on the activities	
16:30-16:40	Wrap up	
October 26 (Tue.)		
7:45	Departing from the hotel to Meru district office	
9:15-9:45	Courtesy call on Meru District Council (District Agriculture, Irrigation and Cooperatives Officer)	
9:45-10:00	Moving from Council to Lekitatu scheme	
10:00-12:30	Meeting with leaders of Lekitatu irrigation scheme,	
12:30-13:30	Lunch	
13:30-14:30	Observation of facilities and rice plants	
14:30-15:00	Moving from Lekitatu site to source of irrigation water	
15:00-15:45	Visiting the source of irrigation water	
15:45-17:00	Departing from Lekitatu to the hotel	
October 27 (Thu.)		
7:45	Departing from the hotel to Lower Moshi IS	
8:00-9:30	Visiting Lower Moshi irrigation scheme	
9:30-10:00	Presentation on the profile of respective schemes (30min/group) 1 schemes	
10:00-10:30	Break	
10:30-12:30	Continue the presentation (4 schemes/120mi)	
12:30-13:30	Lunch	
13:30-15:00	Discussion on management of the scheme	
15:00-15:30	Break	

15:30-17:00	Discussion on management of the scheme	
17:00-17:10	Wrap up	
October 28 (Fri.)		
7:45	Departing from the hotel to KATC	
8:30-9:00	Explanation of the action plan required	
9:00-10:00	Preparation for Action plan	
10:00-10:30	Break	
10:30-12:30	Preparation for Action plan	
12:30-13:30	Lunch	
13:30-15:00	Preparation for Action plan	
15:00-15:30	Break	
15:30-17:00	Preparation for Action plan	
17:00-17:10	Wrap up	
October 29 (Sat.)		
7:45	Departing from the hotel to KATC	
8:30-9:00	Presentation action plan by Kenya	
9:00-9:30	Presentation action plan by Malawi	
9:30-10:00	Presentation action plan by Zambia	
10:00-10:30	Break	
10:30-11:00	Presentation action plan by Uganda	
11:00-11:30	Presentation action plan by Rwanda	
11:30-12:30	General discussions and evaluation	
12:30-13:00	Awarding Ceremony	
13:00-13:15	Closing by DTR Director	
13:15-14:30	Lunch	
October 30 (Sun.)		
	Departing from Moshi	

15) Participants of Target countries

- Participants from JICA office

	Counrty	Name	Title	Remark
1	Zambia	Katongo Richard	Programme Officer for Agriculture, Donor Coordination & Micro Economics	JICA Zambia office
2	Uganda	Lubega Paul	Programme Officer for Rural/Agriculture Development	JICA Uganda office
3	Rwanda	Furaha Pascal	Agriculture Specialist/Program Coordinator	JICA Rwanda office

- Participant List from Target countries

No	Country	Name	Sex	Present post	Organization/ Institute
1	UGANDA	MULONGO Samuel	M	Agricultural Officer	Production & Marketing Department, Bulambuli District Local Government
2	UGANDA	CHEROTIN Patrick	M	Agricultural Officer	Production Department, Kween District Local Government
3	UGANDA	OMALLA Zeburon	M	Agricultural Office	Production Department, Bugili District Local Government
4	KENYA	MWITHIA Daniel	M	Project Officer	Rice Cultivation Department, CaDPERP/Ministry of Agriculture livestock fisheries and cooperatives
5	KENYA	GWARO Laban	M	Water Management Technician	West Kano Irrigation Scheme, National Irrigation Authority (CaDPERP Project)
6	KENYA	ODHIAMBO Wilson	M	Engineer II	Department of Agriculture livestock fisheries and cooperatives, Country Government of Kisumu
7	MALAWI	KUMWENDA Aone	M	Principal Agriculture Officer (Crop)	Department of Crop Development, Ministry of Agriculture
8	MALAWI	MUWANJE Silence	M	Crop Officer	Department of Crops, Ministry of Agriculture Irrigation and Water Development
9	MALAWI	NGOKA Kondwani	M	Senior Assistant Agricultural Research Officer	Department of Agricultural Research Serviced, Ministry of Agriculture
10	ZAMBIA	CHTAMBI Musika	M	Principal Agricultural Research Officer	Zambia Agricultural Research Institute, Ministry of Agriculture
11	ZAMBIA	NYAU Miriam	F	Senior Agricultural Officer	Department of Agriculture, Ministry of Agriculture
12	ZAMBIA	HAMWEETE Osbert	M	Principal Agriculture Officer	Department of Agriculutre, Ministry of Agriculture
13	RWANDA	MANIRAGUHA Jean Baotist	M	Research and Tech Transfer Technician	CROP INNOVATION AND TECHNOLOGYT RANSFER DEPARTMENT, RWANDAAGRICULTURE AND ANIMAL RESOURCES DEVELOPMENT
14	RWANDA	NKURUNZIZA Egide	M	Senior Agronomist	Crop production,Horticulture in Reality Corporation Ltd
15	RWANDA	RUTINDUKA Leonce	M	Agronomist	AGRICULTURE,TWIBUMBE UNION

* No.11 Ms NYAU Miriam could not participate because she could not obtain a proper passport by the deadline.

Entrance to KATC

Opening Ceremony of the Regional Training (Greetings by Dr. Mafuru, DTR)

Group photo of participants

Presentation of irrigated rice farming situation
by country (Uganda team)

Presentation on KATC activities by the KATC

Principal Inspection of
Lekitatu irrigation project site (rice farmer's field)

Action plan presentation

Closing ceremony by Mr. Shauritanga, Principal of KATC

Figure 4- 2. Photos of CARD Regional Training

4-3-3. Results

An evaluation by the participants was conducted on the last day of the training. The results can be summarized as follows.

- Many participants complained about the lack of Internet access, but gave good evaluations of the training content.
- Overall, when asked to rate whether they would recommend this course to all stakeholders, 100% of participants said they would.
- 30% of participants had not received a JICA briefing in their home country.
- Presentation materials for the training were not done before the day of the training.

- The action plan went in a slightly different direction than we intended.[1]
- A WhatsApp group was formed with the participants and the TG group, which facilitated follow-up.
- The deputy director of DTR and many participants suggested that the program should include sightseeing for relaxation.
- The Director of DTR appreciated the active exchange of opinions with participants from other countries on specific technical and institutional differences, using Tanzania as an example, but some suggested that the current program should be given further opportunities to exchange opinions, even if the lecture time is reduced.

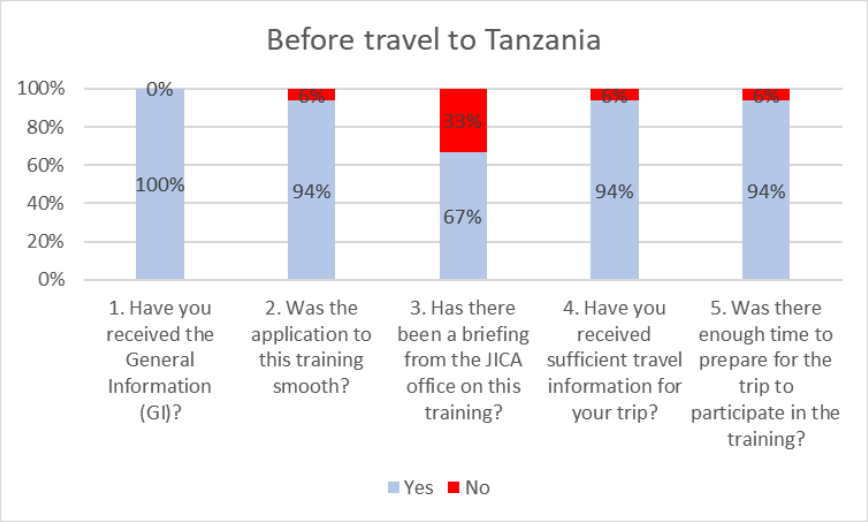


Figure 4- 3. Evaluation of Preparation for the Training

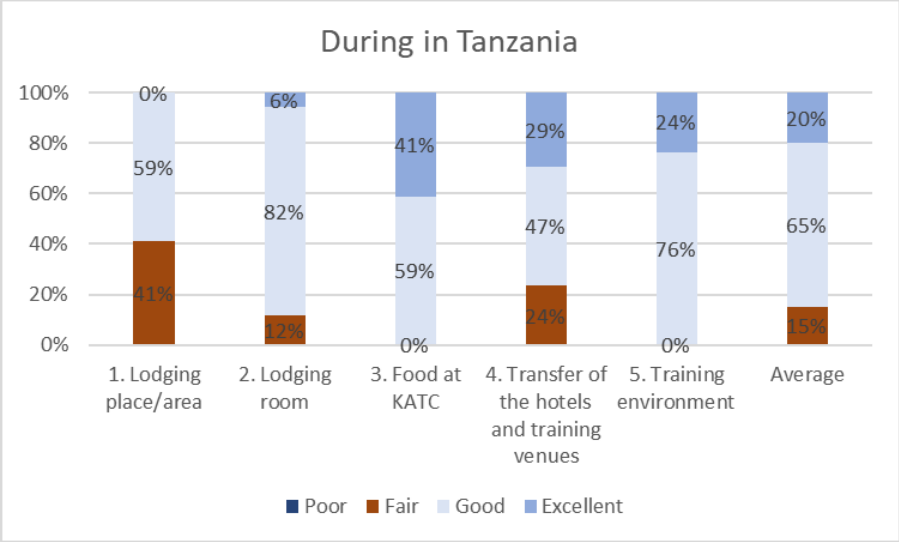


Figure 4- 4. Evaluation of the Training during the trainee' stay

[1] After returning home, the participants were supposed to present their action plans for improving their own work, but they lacked specificity, such as showing the NRDS: National Rice Development Strategy of each country. This was because the participants came from different sites in the same country, while we asked them to prepare and present their own plans for each country. We should have asked them to present their individual plans.

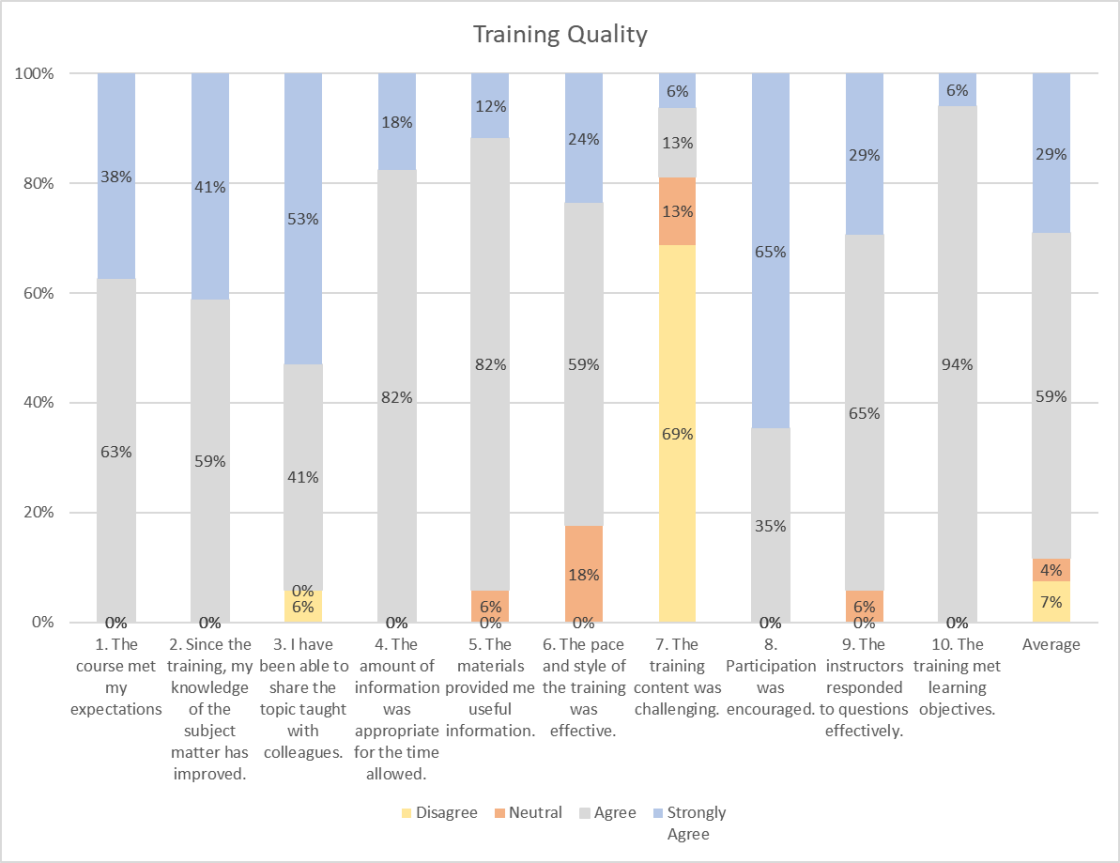


Figure 4- 5. Evaluation of the contents of the Training program

4-4. Suggestions for TANRCE3 Regional Training

1. There is sufficient capacity to handle the implementation stage. Two KATC staff were assigned to the work as the charge of CARD training from the preparation stage, and the KATC treasurer and TG members were utilized as support members, They were trying to make the training go around during the implementation stage too. But it was a considerable burden for them. Other support staff were needed to do miscellaneous tasks in addition to them.
2. The advantage of a CARD training program centered on KATC would be to provide training that encourages interaction rather than standardized technical training. The program should include more time for exchange of ideas. A moderator for this purpose is important. Prospective moderators need to be involved from the time the GI is prepared for implementation, so that he or she fully understand and consider the main purpose, content, and way of proceeding of the training.
3. As a strategic initiative of CARD2, regional cooperation centers have been established in five countries, of which the KATC is one of these centers. If possible, it would be desirable to establish training programs at each center that make the most of regional characteristics while at the same time avoiding duplication of training content, so that the five centers can be used comprehensively and strategically to promote rice cultivation in Africa. In order to revise and enhance the course program, it is desirable to hold a validation meeting with the TG group and related parties to discuss the contents, etc., taking this point into consideration.
4. There were no female participants at this training. Gender balance should be considered.

5. Suggestions for Additional Activities in TANRICE 3

5-1. ToT and farmer training + feedback from participants on the training during the training

5-1-1. Rainfed Rice Cultivation

1. Overall suggestions

1) Selection of introduced (core) techniques

In general, the tutors at KATC and MATIs had sufficient skills and knowledge regarding basic rice cultivation techniques. In contrast, in TANRICE 2, training opportunities and venues for rainfed lowland rice cultivation were limited compared to those for irrigated rice cultivation. Therefore, they did not have sufficient experience concerning a practical understanding of rice cultivation under rainfed conditions, techniques that could be introduced, or methods of improvement (modification).

Under irrigated conditions, achieving a high yield is possible by constructing bunds, leveling the field, planting in rows with low-height seedlings of improved varieties cultivated in the nursery, weeding effectively, applying sufficient fertilizer, managing water according to rice growth, draining water as necessary, and harvesting at the ideal time. Since the commencement of TANRICE, many sites and farmers who participate in irrigated rice cultivation training have achieved high yields.

However, rainfed rice cultivation areas are not located in irrigation schemes or irrigated areas with irrigation facilities but in areas that depend primarily on rainfall and river flood water for irrigation. Cultivation condition is different between irrigated and rainfed areas. Therefore, when conducting training for farmers and extension officers to improve yields in rainfed areas, returning to the fundamental basic rice cultivation techniques, temporarily moving away from condition of “irrigated rice cultivation,” where water can be used at will, and thinking more flexibly, is necessary. In other words, the characteristics of the target rainfed area should be understood, the core techniques introduced by farmers should be tentatively selected, and these technologies should be introduced on a trial basis. This trial-and-error process is necessary to introduce techniques that meet the actual conditions at each site and their acceptance by farmers.

2) Considering the primary institute for conducting training (based on each MATI, depending on the degree of water control)

Because the natural environment and conditions, such as the degree of water control, vary, considering the primary implementation institutions and persons that will conduct training is necessary. It is preferable that each MATI, who is familiar with the situation in the local rainfed rice cultivation area, lead in conducting the training with support from the KATC by making minor modifications and arrangements to the training materials to suit the actual local conditions.

3) Preparing training materials that are adapted to the local environment and actual conditions

Formulating various types of adequate training materials based on the natural environmental conditions of each target area, such as the total amount of rainfall, rainfall pattern, type of irrigation water utilized by rainfall, and land condition, is indispensable and required for effective and efficient training.

2. Training methods

1) Technique dissemination through demonstration plots

It is crucial to establish demonstration plots so farmers can observe and feel the differences and advantages of the introduced techniques and/or methods and their conventional practices and to show them “in the actual field” near the fields of farmers. However, because some farmers cease to manage demonstration plots, and situations where the techniques introduced in demonstration plots are not accepted by farmers, the location, management method, and techniques to be introduced should sufficiently be considered. For example, narrowing the techniques to be introduced to farmers and incorporating extension officers in the management of demonstration plots is indispensable. It is crucial to establish the demonstration plots within the fields of key farmers or other farmers so they easily imitate the techniques and do not feel differences in “environments (condition)” between their own fields and the demonstration plots.

2) Role of extension officers

To disseminate rice cultivation techniques in rainfed rice cultivation areas, where the cultivation environment differs substantially in terms of rainfall and land conditions, extension officers with a good understanding of the actual conditions in the field and specialized knowledge must play a role. Therefore, considering training methods that allow extension officers to cooperate and collaborate with tutors while conducting onsite training is necessary.

5-1-2. Agricultural Machinery

1. Technical guidance for improving the quality of milled rice

Providing technical guidance on the use of agricultural machinery, O&M (operation and maintenance), and management methods, is crucial depending on the size of farms and rice millers. In addition, strengthening management and planning skills for farming and milling operations is necessary to improve the quality of milled rice.

2. Agricultural machinery sales company (safety measures)

In rainfed lowland rice cultivation areas, the plot size is small, the land is irregular, and access to fields is poor. This increases the risk of accidents when tractors and combines are used to move down sloped terrain. Local agricultural distributors include safety measures in their initial training; however, reincorporating safety measures into training can reduce the risk of accidents.

3. Information and Communication Technologies (ICT)

Determining which areas are highly productive from the perspective of water use in the vast area covered by rainfed lowland rice cultivation is currently problematic. In this survey, we found that the use of satellite imaging that was proposed by a private company to identify potential areas, as well as more detailed mapping of areas and terrain using drone aerial photography, is expected to be useful for land use planning by experts and local rice producing farmers. These are information and communication technologies (ICT) that differ from traditional agricultural machinery; however, actual users are likely to overlap with the service industry for agricultural machinery, and also undergoing technical training in their technology is advisable.

4. Collaboration with private sectors and other institutes

Accelerating the mechanization of rice cultivation from the viewpoint of productivity and efficiency is indispensable. Therefore, it is crucial to strengthen cooperation with the private sector on agricultural machinery, and close cooperation with the African Center for Innovation in Agricultural Technology (AFICAT) and Tanzania Agricultural Development Bank (TADB) should be gradually established to promote mechanization.

5. The habit of keeping logbooks

The actual status of agricultural machinery use in TANRICE 2 was difficult to ascertain because it was not recorded in logbooks, and there have been cases where machinery was left unrepaired owing to the inability of farmers to pay maintenance costs. Therefore, it is necessary to support the creation of a system that allows farmers to use agricultural machinery for extended durations by instructing them on creating maintenance management plans and maintaining a logbook during agricultural machinery training.

6. Cost of agricultural machinery services

TANRICE 3 is expected to focus on rainfed lowland rice cultivation areas. However, one challenge for farmers in this area is that they may not afford the cost of agricultural machinery services, as the size is small, and the yield is low. It would be helpful to provide farmers with information on whether it is more economical to hire labor to manually harvest or to use harvesting services using a combine harvester after understanding the cost of this service.

During the harvesting process, understanding local conditions is necessary. If the number of rice cultivation farmers under rainfed condition increases and these cultivation areas expand in the future, accessing medium-sized or larger rice mills in the early stages of development will be difficult, and more farmers will either have small rice mills in their villages or transport their rice to distant mills at higher costs. In such cases, providing information on the locations of local rice mills and transportation costs can help farmers make appropriate decisions.

5-1-3. Irrigation Scheme Management

1. Participants in Irrigation Scheme Management training

Although the organizations of farmers have not observed substantial changes in irrigation project sites where they have received training, the concept remains new to them. Repeated coaching by leaders is necessary to change their perceptions. Furthermore, there is potential for changes in collaboration with the O&M section of the Norfolk Island Regional Council (NIRC). The ISM activities of the project should also be considered in collaboration with the O&M section of the NIRC, ACT, and Japan International Research Center for Agricultural Sciences (JIRCAS) (e.g., training content, timing, and target participants). In addition, periodic ToTs are necessary, not only for beneficiaries. In this case, it would be beneficial for the management of irrigation project sites to include participants from the NIRC, Ministry of Agriculture Headquarters, and the Zanzibar Irrigation Department.

2. Training method

Several irrigated rice fields are unable to use existing irrigation facilities effectively because of the collapse and sedimentation of water intake facilities and canals caused by floods and their inadequate operation and maintenance. Amid limited government budgets, proactively maintaining and repairing irrigation facilities is necessary for beneficiaries, regardless of the size of the irrigation area, to the degree that the burden is not too great. In terms of the operation and maintenance of irrigated areas, incorporating the ISM training of TANRICE 3 into the program of the NIRC would be more effective, and we propose the following collaboration between NIRC and TANRICE 3: An example of such concrete collaboration could be the step-by-step "A. Exchange information on training methods ⇒ B. Unified standards, if necessary ⇒ C. Joint training at one location."

3. Developing guidelines for rainfed rice cultivation

In addition to the current training program using ver. 6 Guidelines designed for irrigated rice production areas, developing new ISM training guidelines and programs for rainfed rice cultivation areas that focus on rainwater harvesting will be necessary.

4. Training costs

The daily subsistence allowance (DSA) includes accommodation (40%), three meals (40%), and out-of-pocket (20%). NIRC O&M training does not fund farmers for training. Snacks and drinks are provided, and lunch is provided if the training continues into the afternoon. Unlike NIRC training, KATC has, in the past, given small funding amounts to farmers when they participated in the training, as job security during their participation, and the cost of this has become substantial when there are a large number of participants. It is undesirable for training organizations to provide funds to some farmers and not to others when training the same farmers. The TANRICE 3 project should clarify the implications of training and the training to be conducted. In addition, in Tanzania, the cost of all materials, equipment, and labor has steadily increased with economic growth, leading to an increase in training and O&M costs. Specifying the details of the burden borne by beneficiaries and establishing a system to ensure the implementation of the details of the burden borne by the parties concerned is necessary.

5. Response to Extreme Weather

Disasters caused by extreme weather events have occurred frequently in recent years, and it is necessary to implement measures (e.g., revision of facility design standards, field-level coordination with Early Warning Systems, and agricultural insurance) for irrigated project sites.

5-1-4. Marketing

1. Training content and guidelines

The "study tour for processors/markets" should be reorganized into training. This content is crucial to increase awareness among farmers regarding rice marketing challenges and to motivate participants. The marketing training of TANRICE follows the SHEP approach and focuses on conducting an initial "study tour

for processors/markets" to change the perspectives of farmers. The financial constraints should not be subtracted from the training pillars.

The order and combination of content are also crucial for ensuring the effectiveness of training. By starting with the study tour, followed by specific marketing skills, and ending with a sales agreement, the participants can be better prepared for negotiation with buyers after a series of training sessions.

Regarding marketing skills (e.g., quality assurance, accounting records, and collective marketing), emphasizing the advantages of modern storage facilities is crucial. Several ISs possess large warehouses with assistance but few members use them. They did not understand that appropriate storage conditions significantly affect business negotiations. One suggestion for "Collective Marketing" and "Access to Finance" is to recommend bank transfers instead of cash payments as a less problematic method of payment.

2. Monitoring

Therefore, the monitoring methods must be re-examined. In TANRICE 2, monitoring was not appropriately conducted, primarily because of financial issues, which may have resulted in an incorrect assessment of project impacts. Only through accurate monitoring can the project obtain adequate feedback to improve training. A redesign of financial resources, methods, and personnel is required.

3. Training budget

Budget cuts are a key issue for sustainable training implementation; however, the question remains whether the previous revision (elimination of the Study tour) was met inappropriately; The "Study tour," where the significance of participating in the training is recognized, and the "Sales Agreement," where the participants apply what they have learned during the training, are two pillars of the training, and removing them would not be appropriate. In contrast, other marketing skills (e.g., quality assurance, accounting records, and collective marketing) could be omitted or their time reduced, as some of the target groups may already have mastered these skills. It is recommended that these contents be selected or shortened to reduce costs, depending on the target participants, budget size, or time availability.

5-1-5. Gender

1. Content and Guidelines

Gender training is well-developed and prepared in terms of content, process, methodology, and materials. In particular, the training is conducted interactively with trainers and farmers through exercises, group discussions, and practical demonstrations, which prevent participants from becoming disinterested. Therefore, this approach should be maintained.

However, this approach requires a high level of teaching skill and experience from a trainer. If trainers misuse this approach and its materials, the training results are halved. Regular training is recommended to avoid such situations, particularly for new trainers.

2. Monitoring

As with the marketing sector, a new monitoring system should be considered.

3. Training budget

Regarding cost reduction, gender training covers several aspects of the lives of farmers, making it difficult to reduce its specific content. The conditions of the target farmers vary by region, farming system, or individual. Therefore, we recommend approaches to select or shorten these contents to reduce costs, depending on the condition of the target group, the severity of the problem, budget size, and availability of time.

5-1-6. Quality Seed Production

To steadily improve rice production in the country as a whole in the future, it is recommended that better seed be used, that farmers themselves recognize the importance of using quality seed, that they can produce and use quality seed themselves, and that in the future, farmers can easily access, purchase, and cultivate quality seed so "It would be desirable for a 'system' or 'structure' to be established so farmers can easily access, purchase, and cultivate quality seeds in the future." Rainfed rice cultivation areas are not necessarily suitable for seed production because the environment is affected by rainfall, flood water, and water, which are crucial for rice cultivation and cannot flow in and out as expected. Therefore, it is preferable for key farmers in irrigated rice cultivation areas who have abundant knowledge, technology, and experience to start seed production and then gradually introduce seed production in rainfed rice cultivation areas when farmers with knowledge and technology have matured in rainfed rice cultivation areas.

For this objective, we propose the following "Quality Seed Production Training" to be implemented in TANRICE 3.

1) Objective

It is crucial to provide training for rice farmers so they can experience the benefits of using quality seeds in terms of productivity (yield) and quality and acquire the skills to produce quality seeds themselves.

2) Contents

In seed production training, conducting QDS production (multiplication) training from the perspectives of quality assurance and acquisition of techniques is realistic. In addition, it is desirable to consider implementing training in seed production (multiplication) techniques with the following points in mind: Based on the actual conditions of the farmers participating in the training and the local situation, the training should enable them to understand the benefits of using high-quality seeds, such as the selection of varieties and removal of off-type plants (rouging).

Technical points include the identification and removal of different varieties of seeds and field preparation (land preparation), sowing, transplanting, weeding, fertilization, harvesting, and cleaning; care should be taken to avoid mixing seeds of different varieties when performing each of these operations.

3) Quality seed production training and seed production activities at training institutions

One activity of TANRICE 3 is to conduct Subject Matter Training (quality seed production) and cooperate with quality seed production activities at training institutes. Some training institutes (e.g., KATC) have already received training from TOSCI, and if they are officially recognized by TOSCI as "seed production institutes" in

terms of institutions (fields and facilities) and human resources aspects, they will be able to publicly conduct training and conduct seed production activities. This would contribute to the increased production of quality seeds and increase the income of the training institute itself, thereby making it financially "self-reliable" in terms of training implementation.

More specifically,

(1) To make farmers aware of the importance of using quality seeds through actual cultivation,
(2) Equip farmers with the knowledge and skills to produce better seeds,
(3) Increase seed supply options for farmers through production at MATIs,
(4) And enable the district to lead in overseeing seed production by farmers to increase the overall production of quality seeds, the following activities are considered crucial:
    - Provide training on quality seed production to farmers
    - Production of quality seed in MATIs
    - Provide training for district agricultural officers to become QDS inspectors

5-2. ToT of Existing Subject Matter Training (five areas) and Monitoring of Farmer Training Results

5-2-1. Rainfed Rice Cultivation

1. Comments from the Ministry of Agriculture (Department of Agricultural Training, Extension Services and Research, DTER: before reorganization)

We recognize that TANRICE 2 training is effective and crucial. However, we believe that it is crucial to convey and connect theory and practice in training, and especially when concerning farmer training, it is crucial to focus on core techniques that farmers can introduce and adopt and to simplify the training materials along this path.

2. Comments from the Ministry of Agriculture (Department of Mechanization and Irrigation: before reorganization)

Rice cultivation in Tanzania requires considerable manual labor, and the ministry recognizes the importance of mechanization, especially during land preparation and harvesting (and weeding and planting, if possible). They also consider the introduction and widespread use of rice-milling machines to be problematic. Because of problems with the skills of technicians who operate and maintain machinery, training for technicians is considered necessary in addition to promoting the introduction of machinery.

3. Comments from TARI (Headquarters)

Several rice farmers use self-collected seeds, which decline in yield and quality during each cropping season. Therefore, training is necessary to help farmers understand the benefits of using high-quality seeds. Concurrently, improving "extension services" to improve the access of farmers to quality seeds would also be crucial.

4. Rice Agronomy TG (KATC) (hearing by survey team on the knowledge and skills of its members)

Members have extensive knowledge and skills in rice cultivation, especially irrigated rice cultivation, and a

certain level of knowledge and skills in rainfed rice cultivation. They have played a crucial role in training (lectures and practical training) activities and have acquired substantial knowledge; however, the survey team sensed that they are standardized in "irrigated rice cultivation techniques." The team asked questions regarding the core techniques of rice cultivation, but possibly because of their extensive knowledge, they provided information after information, making it difficult for the team to sort their answers. As instructors, it is crucial to have a substantial amount of knowledge and skills, and updating them is crucial; however, as individuals in control of conducting the training, it is more crucial to have the "skill" to select the content that is suited to the actual conditions of the target individuals and area on conducting training and to convey it in an appropriate manner.

5. Comments from MATI-Igurusi

Aware of the issue of self-collected seeds at TANRICE, a short training on seed production was conducted at TANRICE 2. This may require expansion in TANRICE 3 to include training in quality seed production. In addition, difficulties were observed in transferring the techniques from demonstration plots to the plots of other farmers, and studying methods to disseminate these techniques is necessary. In terms of detailed techniques, tutors at MATI-Igurusi attempted to introduce the sowing methods (drilling and dibbling) and making bunds learned in TANRICE 2. However, farmers conducted sowing by broadcasting and they did not construct bunds; therefore, the content of the technology and transfer methods must be discussed.

6. Comments from MATI-Ilonga

The training period for TANRICE 2 was short, and the dissemination of the human-powered (hand-pushed) weeder that was learned was difficult due to water control. Attempts were made to introduce NERICA1; however, the yield was low, and tutors of MATI-Ilonga want to introduce other NERICA varieties in the future.

7. Feedback from farmers participating in the training (based on the results of the re-entrusted survey by the SUA)

1） Target states: Nine regions were selected from the regions where training was conducted by TANRICE 2

2） The number of farmers interviewed: 102 (57 men and 45 women)

3） Evaluation of training methods, materials, and items

- Most participants rated the training methods (lectures, practical training, and study tours) as "appropriate." In particular, regarding practical training and farmer field visits, the participants evaluated that they were able to "reinforce" the skills acquired in the lectures in the field in accordance with the literal meaning of "seeing is believing."
- The training materials (slides, documents, and handouts) were also evaluated as aligning with the training objectives and content, and appropriate materials were prepared.
- The training items [characteristics and growth of rice varieties, land preparation (bund making and leveling), seed preparation, making and sowing a nursery, transplanting, direct sowing, weed control, fertilizer application, water management, pest control, harvest and post-harvest treatment techniques,

demonstration plot preparation, farm diary, and dissemination methods of techniques] covered approximately all of the crucial technologies related to rice cultivation. The “items” were evaluated as “appropriate” and “adequate,” as they covered approximately all of the crucial technologies related to rice cultivation. However, the technologies adopted (introduced) and continued to be implemented in the fields of farmers varied. In other words, the results of this survey indicated that continuously examining the “technologies to be introduced” while considering the actual conditions in the field is necessary because which technologies can be adopted and continued in the fields of the farmer depends on the local environment and conditions. Half of the farmers did not use Farm Record. Reasons given included “don't have time to write” and “don't think it is beneficial.” The survey also noted that it depends on the “unfamiliarity” and “lack of awareness of its usefulness” of the farmers. Therefore, in TANRICE 2.5, the Rice Farming Handbook was created as an alternative to the Farm Record based on the understanding among TG members that it should be easily understood by farmers and that it is simple and easy to write while taking advantage of the features of the Farm Record.

4） Evaluation of “core technologies” in TANRICE 2 rainfed lowland rice cultivation training

- In the rainfed lowland rice cultivation training program at TANRICE 2, various irrigated rice cultivation techniques were presented to the participants, and a technology transfer was conducted through lectures and practical training. In particular, in the training program for rainfed lowland rice cultivation, “bund making,” “land leveling,” “line planting,” “fertilizer application,” and “use of improved varieties” were considered as “core techniques,” and emphasis has been placed on their dissemination, with the degree of dissemination (adoption by farmers) of these techniques evaluated as “results” of the training program (evaluation at the end of TANRICE 2).
- In this survey, participating farmers rated all of these “core techniques” as “useful.” Among these, the highest number of farmers rated the “construction of bund” as “useful,” and several farmers have been implementing (adopting) it. The cause of this, according to the farmers, is that in rainfed rice cultivation areas, irrigation water is obtained under conditions that primarily depend on rainfall, and securing this limited and valued water is crucial. The explanation was that the “construction of bund” is “useful” and is being implemented (adopted). From the same perspective, the importance of “land leveling” can also be highlighted.
- Techniques that were not included in the “core techniques” but were highly rated as “useful” were the “use of quality seeds.” Many farmers currently use self-collected seeds; however, it is theorized that several have recognized the benefits of using quality seeds through training. Increasing the awareness of farmers regarding the merits and advantages of using quality seeds is crucial, but solving the problem of limited “access” to quality seeds in terms of “availability” and "price” is also crucial. Therefore, as part of the Subject Matter Training in TANRICE 3, “training on the production of quality seeds” will be conducted to help farmers realize the benefits of using quality seeds and learn techniques (seed production techniques) to independently produce quality seeds, which will increase the use and production of quality seeds by farmers.

5） Regarding NERICA

- Several participating farmers indicated that NERICA had higher yields than previous varieties but that it was susceptible to drought, and most importantly, its eating quality was poor, making it less marketable. The low yield and poor eating quality of NERICA were also revealed in the ToT and farmer training interviews conducted during TANRICE 2.5. Therefore, in the future, the "Rainfed upland rice cultivation training" will not be limited to NERICA but will also include information on other upland rice varieties and cultivation methods and will cover various upland rice varieties. Therefore, the title of the training material was also changed from "NERICA cultivation training" to "upland rice cultivation training."

6) Yield

- Among the interviewed farmers, 78.4% admitted that there was an increase in yield after participating in TANRICE 2 training. In contrast, 21.8% of the interviewed farmers indicated that training did not increase yields. Since these farmers who indicated that the training program "did not lead to increased yields" also indicated that the training program was "beneficial," the survey also presented the following issues: Did the farmers correctly and accurately apply the skills they learned during the training in the field? In addition, there were other unresolved issues, such as salinity problems, soil fertility, and the availability of irrigation water.
- For those issues that can be solved or improved, measures will be taken, and in cases where it is difficult, "introduction techniques" for increasing yields will be considered and introduced on a trial basis, considering such situations.

7) Changes after participation in training

- More than 70% of farmers answered that an increase in yield and income from training improved their livelihoods. In particular, they reported that they could improve the environment of their homes (through renovation and repair) and increase the cost of the education of their children.

8) Requests from Participating Farmers

- Several farmers indicated the need to conduct retraining. The reasons for this were that it was necessary to participate in the training again to reconfirm the techniques and their introduction if they had not had the opportunity to practice them in the fields of the farmers, that new techniques were being developed every day, and that farmers had no other opportunity to experience and learn such techniques except for participating in these training programs.
- Specific topics included pest control, the characteristics of high-yielding varieties, and transplanting methods. New topics include pesticide application, soil analysis, seed production techniques, and mechanized direct seeding techniques.

9) Recommendations from this study

- Simple and user-friendly training programs should be considered and implemented, considering the ease of understanding by farmers and ease of implementation in the fields of farmers.
- The timing of training should be based on the cropping systems (cropping calendar) of farmers so farmers can apply the techniques they have learned in the field.
- As for training items, training on "quality seed production techniques," which has been requested by several farmers, should be implemented.

5-2-2. Agricultural Machinery

1. Feedback from farmers participating in ToT and training

In TANRICE 2, it was observed that users of agricultural machinery in various regions did not keep work records (logbooks), making it difficult to grasp the actual situation. There were cases of farmers leaving farm machinery after it malfunctioned because they could not cover the cost of using it. Therefore, it is desirable to support the creation of a system that enables users to use agricultural machinery for an extended period by instructing them to create an operation and maintenance management plan and to make a habit of keeping work records during agricultural machinery training.

In addition, TANRICE 3 is expected to focus on rice cultivation in rainfed and lowland areas, and one issue regarding agricultural machinery is that farmers cannot increase the amount of money they can pay for agricultural machinery services because the area per plot is small, and the yield per crop is low. In the harvesting process, combined harvesters are also used for small plots; however, it may be useful to provide information on the price of harvesting services and whether it is more economical for farmers to hire laborers to harvest rice manually.

In rainfed lowland rice cultivation, the area of each brushstroke is small, the terrain is undulating, and access to fields is poor. This is likely to lead to accidents when the power tiller or combine harvester moves over sloping terrain as they perform their respective services. Local distributors include safety measures in their initial training; however, incorporating safety measures into training would help reduce the risk of accidents.

While understanding the actual local conditions is necessary, we expect that access to medium- or larger-sized rice mills will become more difficult and that there will be more opportunities for farmers to either set up small rice mills in villages or transport their rice to distant mills at the cost of transportation. One measure that could be taken is to provide support for mobile rice mills that include a small rice milling machine and stone remover, as has been applied in the past, or to support the maintenance of rice polishing machines in small rice mills.

Furthermore, determining which areas are highly productive from the standpoint of water use in the vast areas of rainfed lowland rice cultivation is difficult. The use of satellite imagery proposed by a private company in this study to identify potential areas and the subsequent use of aerial drone photography to obtain a more detailed understanding of the area and topography will be useful for land-use planning by experts and local rice farmers. Although these ICT techniques differ from conventional agricultural machinery, actual users will likely overlap with the service industry for agricultural machinery, and technical training can be provided in conjunction with these techniques.

2. Summary of the results of the re-entrusted study by SUA

1) Training Methods

The training was suitable for trainees to understand the contents provided in the lecture after the field visit. However, it was found that most farmers do not own these machines, which limits their ability to put them into practice.

2) Role of farm machinery in expanding the paddy field area

The details of the use of power tillers in the expansion of rice cultivation from small- to medium-sized plots were well understood, indicating that most farmers who received training understood the subject matter. The problem is that farmers of small plots of privately owned land find it difficult to break boundaries and use agricultural machinery, thus limiting their use, despite the perceived usefulness of the training.

3) Leveling of paddy fields by machinery

The favorable evaluations of farmers regarding the training content, materials, and methods were observed for almost all topics. Most farmers understood the use of power tillers and wood levelers to level rice paddy fields.

4) Mechanization of rice harvesting

The training content on mechanized harvesting using a harvest combine (KUBOTA) was also recognized as useful but inaccessible for smallholder farmers. Despite if they belong to a farming group, they cannot afford to own such machinery. Furthermore, it was noted that most farmers were small farmers, and their land was fragmented (they could not expand their small plots), which prevented them from using such machinery, as the machines could not move freely across the field. Therefore, the same farmers may be able to use them in the future when their rice farming operations expand. However, the content was not applicable at that time.

5) Rice milling machine

The content that packaged both the theory and practice of rice milling was highly praised by most farmers as useful. This content is considered useful for improving production efficiency and rice quality. In contrast, respondents indicated that rice milling theory and the operation and maintenance of rice milling machines were not practical at the household level, as they did not plan to own a rice milling machine. Most farmers and respondents who participated in the training were not rice mill operators, apart from farmers who sold milled rice and were found to have a particular need for knowledge in this area. This trend holds true for the training of rice-milling machine parts, milling machine operations, and maintenance.

5-2-3. Irrigation Scheme Management

1. Interviews in irrigation schemes (IS)

Seven irrigation project sites where Subject Matter Training had been conducted by TANRICE in the past and where the training had been effective were visited and discussed with local officials regarding the effectiveness of past training. When selecting the sites to be surveyed, we considered whether irrigation sites could contribute to CARD-wide training.

(1) Ndungu IS (Sme Region): Well-functioning organization.
(2) Mombo IS (Korogwe): This is also a PHDR (Policy and Human Resources Development Fund) site that remains a good district.
(3) Mbalnagwe IS (Morogoro Rural District): The generation has changed, and organizations have lost cohesion.
(4) Kivulini IS (Mwanga District): Agricultural machinery introduced under the PHDR system is already unusable, except for rice milling machines.

(5) Lekitatu IS (Arusha Region): Although it remains a good area under the PHDR, urbanization is progressing due to generational change, and farmlands are being reduced.
(6) Kizimbani IS (Zanzibar Region): Pump irrigation. Farmers are dependent on the government.
(7) Mwega IS (Morogoro Rural Region): Facilities are well maintained.

Representatives from four sites (Ndung IS, Mombo IS, Lekitatu IS, and Mwega IS) were invited to participate in a regional training program to exchange views with participants from other countries on the management status of each site.

2. Discussions with TG members

After the completion of TANARICE2, the TG remained inactive for approximately 3 y. With new members joining, reviewing the training content of TG members in preparation for TANRICE 3 is necessary. In addition, there are participants from organizations other than MATI tutors, and an overall review of existing training programs is desired. Furthermore, owing to the extended inactivity period, revising the terminology and procedures that no longer fit the existing guidelines and costs associated with the training was necessary. Regarding the content of the training, considering the following issues is necessary: “Improvement of criteria for selecting project sites for training,” “Information sharing between farmers and the organization leaders of farmers and its methods,” and “Monitoring of project sites to understand changes over time.” Regarding the timing of training, MATI is busy in June with end-of-year examinations and preparations for graduation and enrollment. We decided to exclude this period from the training conducted by the TG members of MATI.

3. Comments from the NIRC (DG, Ag. DG, Regional Engineer)

Training on the operation and management of irrigation schemes in TANRICE 2.5 and TANRICE 3 is related to training on the operation and management of ISs. It will be welcomed if training on the operation and management of ISs can be provided to relevant MATI engineers in TANRICE 2.5 and TANRICE 3.

According to the O&M section of the NIRC, 300 scheme managers will be hired and deployed to registered irrigation sites by FY2022. The O&M section hopes to cooperate with TANRICE 3 either by inviting members of each other to ToT training or by jointly conducting training to build the capacity of each other. The Regional Irrigation offices in Kilimanjaro, Mbeya, and Morogoro also expressed views similar to those of the HQ.

4. Comments from ATC: Arusha Technical College (Deputy Rector)

The ATC is closely related to JICA and JIRCAS. They wanted to maintain their relationship with TANRICE3.

5. Results of the SUA re-entrusted survey

According to the results of the farmer survey, ISM training at several irrigation project sites was “useful” for more than 80% of the respondents in each category, regardless of the region. Interviews with extension and irrigation officers also revealed almost the same opinions as the farmers. In particular, regarding the usefulness and applicability of the training, it reduced some conflicts in ISs, such as water conflicts, water use efficiency, and proper management of organizational funds. In addition, the respondents indicated that they were more

open to the use of funds, including for infrastructure maintenance.

However, some respondents from the farmers mentioned that after the training, there were conflicts due to changes in leadership and poor financial management of the contributions of farmers, especially in irrigation organizations. Therefore, when new leaders who had not received previous training were appointed, each time a leader was changed, the respondents indicated that training should be continued. When asked if they used these skills on their own farms, only those farmers who farmed in areas with irrigation facilities indicated that they felt that the skills they had acquired were valuable.

Based on these results, two recommendations can be made regarding TANRICE 3 activities. First, the training effects would be more visible if training targets were selected in areas where irrigation facilities have already been established. However, there are few areas where irrigation facilities have been established, and several of these facilities are inadequately designed and constructed, poorly maintained, and unable to function as a foundation for irrigated rice cultivation due to flooding. Therefore, it is expected to develop training materials and programs based on the current training materials, including technical aspects of the facilities in cooperation with the NIRC and ATC and financing issues in case large-scale renovation is required, so training can be effective following the training period. Second, training materials and programs that address issues such as funding if large-scale renovations are necessary to achieve concrete results after training should be developed.

Second, measures should be taken to deal with changes in instructors and the existence of instructors who do not faithfully fulfill their roles. It is expected that training will be repeated once and also regularly and that follow-ups will be conducted after the training to monitor changes in the project sites and create a mechanism for the concept of ISM training to be established among farmers in the project sites.

6. Mainland and Zanzibar activities

There is a difference between the mainland and Zanzibar in the measures of burden related to the construction and maintenance of facilities at paddy irrigated rice project sites. In Zanzibar, the government continues to oversee rice cultivation in general, whereas the beneficiaries of the projects on the mainland bear part of the construction costs and leave the maintenance to farmers to the highest extent possible. The government is promoting rice cultivation in Zanzibar to increase self-sufficiency; however, the development of rice cultivation has been led by the government in the past. In the case of Zanzibar, it is necessary to first spread the understanding of participatory management, including the maintenance of irrigated paddy field facilities.

5-2-4. Marketing

1. Irrigation scheme (IS) survey

A marketing survey was conducted during three field surveys beginning in March 2022. Seventeen ISs in which TANRICE training had been conducted in the past were visited (Table 5-1).

Of the seventeen ISs, eleven owned grain warehouses, and nine owned rice mills. Most warehouses and rice mills were provided by the PHRD, Expanding Rice Production Project (ERPP), and district governments. Warehouses are large, ranging from 1,000 to 4,000 t, but are not always effectively utilized, and some are rented to non-members.

The rice milling machines provided by the PHRD are of the small-unit type, but they do not have a grader. Because sorting increases the selling price (approximately 100 TZS/kg), some ISs have installed small, locally made sorting machines.

Seed renewal was conducted in most of the ISs visited, although not every year. In particular, several ISs in the Morogoro region purchase certified seeds from ASA and other official institutions annually. Observations of white rice polished using a local rice-milling machine showed little red rice or a mixture of different varieties, confirming the reality of seed renewal.

Collective marketing, which was recommended in the final report of TANRICE 2 to be introduced into the training program, was only implemented by a few farmers in Mbuyuni IS, Mbarali District, and the Mbeya Region on a limited basis. Of the seventeen ISs visited, eight had both a rice milling machine and a warehouse, which are favorable conditions for collective marketing. However, there was some reluctance to engage in joint sales due to a lack of success stories and funds for purchase by the irrigation organization, although there was interest.

Milled rice polished by a rice milling machine owned by Lekitatu IS

Warehouse owned by Lekitatu IS (inside)

Warehouse owned by Mvumi IS

Small sorting machine owned by Ifakara IS

Figure 5- 1. Photograph of marketing irrigation scheme (IS) survey

Table 5- 1. Rice milling machines and warehouses owned by each IS and seed renewal status

	Location	IS Name	Rice milling machine	Warehouse	Seed renewal
1	Morogoro, Ilonga	Ilonga-IS	None	Nome	Renewed annually (SARO5) Purchased at TARI, ASA for 2500 TZS/kg.
2	Morogoro, Kilosa	Mvumi-IS	Two rice milling machine units	Yes, Large size	(No information)
3	Morogoro, Kilombero	Mkula-IS	Rice milling machine unit	Yes, Large size	Renewed annually (SARO5) Purchased from KATRIN for 2500 TZS/kg
4	Pwani, Bagamoyo	Bagamoyo-IS	Rice milling machine unit	Yes, Large size	Renewed annually (SARO5) purchased from Morogoro ASA for 2750 TZS/kg
5	Kilimanjaro	Lower Moshi, Mawala IS	None	Yes, Large size (2 locations)	Renewed annually (SARO5) 2000 TZS/kg purchased from KATC, KADP, etc.
6	Arusha	Lekitatu-IS	Rice milling machine unit	Yes, Large size	Renewed annually (SARO5) Purchased from Morogoro ASA for 2500 TZS/kg and sold to members for 3250 TZS/kg.
7	Manyara, Babati	Muungano-IS	Rice milling machine unit	Yes	SARO5 initially purchased for 5,000 TZS/5 kg (government encouraged), later 1,800 TZS/kg, now self-collection
8	Zanzibar, Unguja	Bumbwisudi-IS	None	None	Trained in seed production and producing; 2,000–2,500 TZS/kg (some but not all purchased) SARO5, TXD88,SupaB/C
9	Zanzibar, Unguja	Cheju-IS,	None	None	First purchased in 2014, then self-collected SARO5, SupaB/C
10	Zanzibar, Unguja	Mtwango-IS	Small SB type	None	Improved species: SupaB/C, SARO5, and TXD88, Local species: Supa India, Bawa mbili, Kalamata, and Suban, self-collected
11	Mbeya, Mbarail	Mbuyuni-IS,	Rice milling machine unit	Yes	SARO5 (grown by 70–75% of the members), seed produced (self-collected)
12	Mbeya, Mbarail	Uturo-IS	Rice mill unit (halted due to electrical problems)	Yes	Seed production but self-collected SARO5 (TXD306) Local species: Mwenda mBio, Kalamata
13	Mbeya, Mbarail	Ipatagwa-IS	Rice milling machine unit	Yes	Two individuals trained in seed production; SARO5 2,500 TZS/kg (not all are buying) 2 kg each initially distributed by DAKAWA. Local seed is approximately 2 or 3%.
14	Mbeya, Kyela	Ngana IS	None (transported to city)	Yes	SARO5 is declining, local species: Kilombero, Daudi, Zambia, Rangi mbili self-collection
15	Dodoma, Bahi	Bahi-IS	None (uses rice mill/warehouse in the city center)	None	Self-collection, local species: Bawa mbili (bird damage free), Ganyaro, Supa zambia, Supa dakawa Some SARO5
16	Shinyanga, Shinyanga	Nyida-IS	None	Yes	(No information)
17	Shinyanga, Msalala	Chela-IS	None	None	(No information)

2. Business type of rice mill

In Tanzania, the trading price of rice is generally low during the harvest season from April to June and gradually rises by September. Farmers who have access to adequate storage facilities and do not need funds immediately after harvesting can sell when prices rise. In addition, the price of rice is the lowest when sold as a paddy at the yard sale, and if there is a rice mill nearby, the price is higher when sold as white rice at the mill, even if the costs of transportation and milling are deducted. Furthermore, passing rice through a grader increases the price. Farmers are aware that the level of rice milling affects the price, so they use the milling machine in the village for home rice and travel to a distant rice mill with a better machine for sale.

Rice is traded in two or three grades based on its aroma, broken rice ratio, and other factors. The price difference between the grades was approximately 100–200 TZS/kg. Another characteristic of rice is that there is no resistance to mixed varieties because the production location is more crucial than the variety (although grain lengths are matched so as not to be mistaken for broken rice).

Several private rice mills do not always purchase rice, as they only offer rice milling services, and their primary income source is milling fees and byproduct bran. They offer free or substantially low storage fees if rice milling is performed at their facility to secure rice milling volume. Some companies offer loans to warehouse users. The advantages of using an IS warehouse may be lesser if a private actor offers a service that is more convenient for farmers.

Some large rice mills buy and store paddy and sell milled rice in small quantities depending on market demand. They also supply bulk quantities to large cities after grading in response to distributor requests. Some rice mills can be converted into more sophisticated rice-milling machines.

Larger rice milling companies have their agents located in the production area to purchase paddies directly from farmers at the production site. When a specific amount is collected, it is transported to the mill, where it is milled, sorted, bagged, and sold to wholesale dealers. Some own kiosks that sell directly to local consumers.

3. Examples of collective rice sales in Tanzania

Since no ISs surveyed were engaged in collective marketing, a survey of organizations (e.g., private companies, farmer groups) that had experience in joint sales was conducted (Table 5-2). Although some organizations had already halted joint sales, the following two points were common to those that were moderately successful in joint sales:

(1) They offer multiple production and financial services to support producers (especially loan programs suitable for those waiting until the appropriate time to sell).
(2) They use bank accounts and do not handle cash (which considerably reduces the incidence of difficulties within the organization).

Another effective form of joint sales is to provide only market facilities and a trading floor without involvement in transactions, as in the case of MVIWATA and UVIBUKA AMCOS LTD. (see Table 5-2 below).

Examples of the warehouse receipt system are found in the Mkasu Farmers Association (Kilombero District) and AMCOS-PAKATI (Kyela District), both of which were not already implementing it. In contrast, two

associations in the Mbarali Region showed strong interest in the warehouse receipt system because it would significantly increase their capacity to purchase paddy.

Table 5- 2. Examples of Joint Marketing in Various Locations

	Organization Name	Location	Activity	Performance
1	Mkasu Farmers Association	Kiberege ward, Ifakara TC, Kilombero	In 2010, a rice milling machine was provided with the support of NGO RUDI (funded by USAID), and a joint sale was conducted with the warehouse receipt system. However, due to leadership and management issues, the project was suspended after a short period. Four private rice mills in the village provide free rice milling service and warehousing (rice bran as compensation).	Inactive during 2017 (actually active for approximately 5 y)
2	MVIWATA* Igurusi Rice Market	Igurusi, Mbarali District, Mbeya	A rice market facility dedicated to the rice of Morogoro-based farmers. It provides a trading floor, rice mill (6,000 TZS/100 kg white rice), and warehouse. Rice is sold under the brand name of the Federation, KORIE Rice. However, the Federation only provides market facilities and does not intervene in trading. Trading occurs directly between producers and traders.	Active; a third rice milling unit is being established. Donor support is readily available.
3	AZIMIO MSWISWI High Quality Rice Millers Co. Ltd.	Mbarali District, Mbeya	Rice Business Corporation, incorporated in 2012 with guidance from RUDI to facilitate access to financial support, was active in 2016. (1) Saving & credit, (2) paddy purchase, rice milling, joint sales, (3) input sales, (4) combine harvester and power tiller rental, (5) warehousing services, and (6) transportation services. Provides a variety of services to increase the number of users. All transactions are bank transfers.	Good. Has the stamina to wait for 2 y when rice prices were low without selling rice.
4	Mbarali Neighbors Rice Farmers Trading Company, Ltd.（MTC）	Ilongo, Mbarali District, Mbeya	Established a rice business company in 2021 with support from the COMRICE project (funded by Norway). (1) Farmer training, (2) SRI guidance, (3) input store, and (4) combine harvester and transportation service. (5) Purchase, milling, and joint sales of paddy. Preparing finance for farmers (input loan has already started). Similar to AZIMIO above. All transactions are remitted through bank transfers.	It is difficult to judge since it has been established last year; however, its activities are expanding.
5	AMCOS-PAKATI	Kyela District, Mbeya	Established in 2015 to implement a warehouse receipt system with government support (cocoa and rice). The receipt system is funded by a loan from the bank. Joint sales are conducted, and a major trading partner is the Mbeya Rice Group. Transactions are in cash (Kakao uses bank accounts).	Moderately stagnant. There appears to be delinquent loan repayments.
6	Mbeya Rice Group	Mbeya Urban、Mbeya	Association of 23 rice mill owners. The association includes a group of machine operators, transportation services, rice traders/retailers, and other small groups (all registered organizations), forming a rice cluster. Joint sales are conducted, and the timing of sales is discussed and decided within the group. The groups work together to solve problems within the group), for	Small rice mill owners are steadily developing their activities. Currently leases land in the industrial park of SIDO but has

			example, by providing compensation in case of loss of cargo. Various training programs are also provided. Each group has a credit system. In the past, rice was purchased under agreement from agricultural groups in the Mbeya Region; however, transactions are currently market-based.	purchased land in Mbuyuni District.
7	Musoma Food Company (MFC), Kishapu Food Processor Company Limited (KFP)	Shinyanga & Kishapu District, Shinyanga	Purchases paddy from farmers under the CARI project (already completed) in Shinyanga MFC and also sells branded rice. To help rice mills secure quality paddy, MFC provides warehousing services, financial loans, and seed and fertilizer credits.	Various services are offered to help rice mills that want to secure quantity to its surrounding farmers. The company has not yet engaged in contract farming.
8	Shyrice Group	Shinyanga	In 2012, a group of farmers that started with VICOBA started a joint shipment of paddy with the support of Oxfam International. The company has a rice mill and grain warehouse. The warehouse was built with 70% support from VICOBA and 30% from the district. One of the members has received QDS training and is producing seeds.	Its management situation is good. Production volume has increased due to the successful implementation of production techniques support, and the volume of sales has also increased.
9	UVIBUKA AMCOS, LTD.	Msalala District, Shinyanga	Constructed a warehouse in 2018 in the rice mill cluster area in Burige village. It has 210 members and provides storage services for maize, sunflower seed, and paddy (1,500 TZS/bag). Sales are conducted privately, and no credit or other services are offered. AMCOS provides a venue for transactions but does not intervene in the substance of the transactions.	AMCOS provides a forum for trading but does not intervene in the substance of the transaction.

* Mtandao wa Vikundi vya Wakulima Tanzania -**MVIWATA** is a Swahili acronym for National Networks of Small-Scale Farmers Group in Tanzania. Founded in 1993, **MVIWATA** is aiming to unite smallholder farmers in group and networks in order to protect their interests through capacity development, facilitating communication and advocacy on policies and systems

Warehouse in Azimio (Igurusi, Mbeya)

Agricultural supply store of MTC (Mbeya)

Paddy trading floor of MVIWATA (Ilongo, Mbarali)

Rice milling unit of MVIWATA (made in China) (Ilongo, Mbarali)

Figure 5- 2. Photos of the business conducting situation of the rice mills

4. Interviews at MATI

Through interviews with marketing TG members (including former members) belonging to KATC, MATI-Ilonga, MATI-Igurusi, and SoA during the field survey in March 2022, and through e-mail discussions with TG leaders belonging to MATI-Mwanza, the current status of Marketing TG was confirmed, and the details of the implementation of the ToT were finalized.

Six of the fourteen TG members in TANRICE 2 were vacant because of transfers, retirement, or extended vacations. After the nomination of new members by the respective MATI principals and the return of the old members, the TG was finally reconstituted with fourteen members, including four new members.

Since the end of TANRICE 2 in 2018, the TG has not voluntarily conducted any TANRICE 2 training but has conducted training for farmers on specific topics (e.g., rice quality assurance) at the request of NGOs and other organizations.

In addition, since TG members have been teaching students as faculty members of MATI, no problems were experienced regarding teaching ability and the ability to prepare training materials.

5. Results of the re-entrusted survey by SUA

The following summarizes the results of a survey conducted on past TANRICE training participants to determine the effectiveness of the TANRICE training program. The survey focused on questions regarding the usefulness of the five basic training items (study tour of processors/markets, quality assurance, market information, record keeping and accounting, and agreement on terms of trade), the use of the techniques, and the reasons for not using them. No regional differences were observed in the responses.

- Study Tour (visits to rice millers, local markets, etc.): 80% rated the method of learning regarding the market value of storing and milling rice as “Very useful”; 7% stated it was “not so useful”; however, there was no difference in the percentage of respondents who said that their reasoning was the lack of practicality due to the lack of nearby facilities.
- Quality assurance: Concerning most technologies (e.g., the appropriate harvest time, weed control and variety purity, threshing and sorting, proper drying, packing, hulling, grading, and packaging of milled rice), the adoption rate was good with high ratings. However, the items related to maintaining the quality of milled rice were rated low by some farmers who primarily sell paddies.

- Information Sharing: Market research using cell phone messages was rated as “Very useful” by slightly under 60% of respondents, while “Not so useful (7%)” and “did not understand the subject (8.5%)” were rated “Very useful” by a few respondents. “Not so useful (7%)” and “did not understand the subject (8.5%)” were also found in a small number of responses.
- Record keeping and accounting: 88% rated it as “very useful,” and 74% still kept records.
- Meetings and sales agreements of stakeholders: 58% found them “very useful,” 25% “useful,” and 13% “not so useful.” In addition, 32% mentioned that they had adopted the techniques once but halted, and only 19% mentioned that they continued using them. Unlike other technologies, this activity requires negotiation with the buyer, which is believed to increase the difficulty.

5-2-5. Gender

1. Hearing survey

The 2022 Global Gender Gap Index of Tanzania was 0.719, ranking 64th among 146 countries, which is higher than the overall average of 0.681 (Global Gender Gap Report 2022, World Economic Forum).

During the field survey in March 2022, we could not visit the IS where gender issue-specific training was conducted; therefore, we could not ascertain the effectiveness of the training. However, it was apparent that the overall gender balance was maintained, as most members of the ISs visited were women, and women were always included in the executives of the organization, possibly because the country has been focusing on gender education.

2. Results of the re-entrusted survey by SUA

1) Evaluation of Gender Training

Gender training left a lasting impression on the participants, with 99% of them remembering having attended gender training.

Regarding changes in their lives after attending training, positive responses exceeded negative responses in all areas: family health, family housing, child education, family problems, and village standards of living.

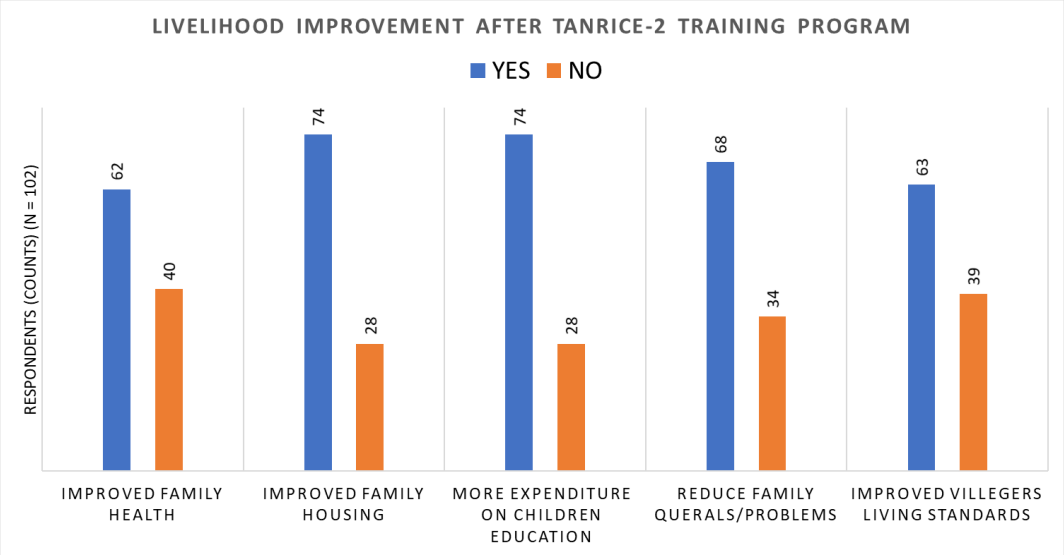


Figure 5- 3. Livelihood Improvement after TANRICE 2 Training Program

The survey report notes that the responses of respondents to gender questions were primarily positive and that the adoption rate of the techniques was high. Several respondents had been provided with gender training by various organizations, including the government and NGOs, prior to the TANRICE 2 training program, which provided a good grounding for acceptance of the techniques.

The following is a summary of the results of the responses to each training item.

- Joint Decision-Making and Family Action Plan Implementation: Over 90% rated it as "very useful," and over 80% still employed this knowledge.
- Gender equality in household income and expenditure decisions: 97% rated this knowledge as "very useful," while 99% still adopted it.
- Personal and household environmental hygiene: Adopted by the majority, and field observations confirm that it is practiced.
- HIV/AIDS: The vast majority (80–100%) replied "very useful" to questions regarding HIV/AIDS (e.g., accurate information about HIV/AIDS, awareness regarding the underlying causes and prevalence of HIV/AIDS, risk and non-risk behaviors, the impact of HIV/AIDS on agricultural production).
- Although the overall evaluation of gender training was high, the lack of practical demonstrations of measures regarding HIV/AIDS and personal and household hygiene was identified as a weakness.

2) Behavioral changes after attending the training

The survey showed behavioral changes in the households of participants after the TANRICE 2 training.

- Economy: In each region, 62.5–100% of the household expenses of the participants were determined through discussions between men and women (implemented in a more collaborative manner). Some participants stated that women alone were more likely to make spending decisions, thus reducing the number of family problems related to money.

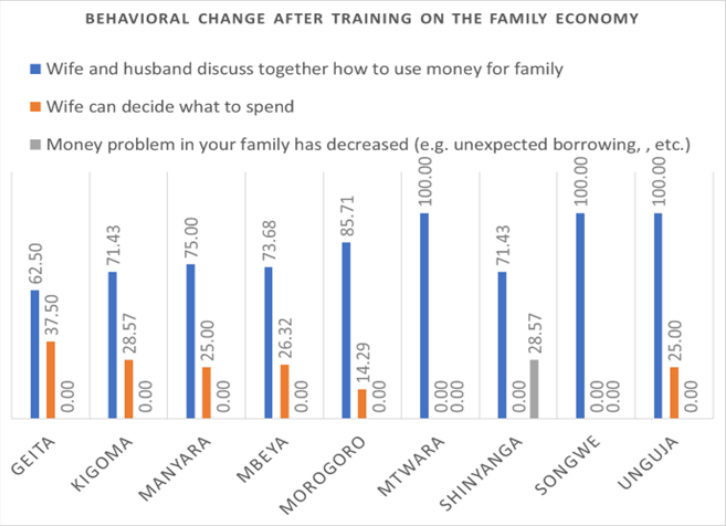


Figure 5- 4. Behavioral changes after the training (1)

- Education: The impact on child education was confirmed in rice farming families; more than 60% of households had daughters attending college after TANRICE 2 training, and more daughters were attending secondary education at the community level.
- Health and living: Regional differences in response trends were observed for this item. The participation of men in housekeeping remains a challenge, with 42.8% of respondents in Shinyanga indicating that their husbands are doing more housework and childcare, while in other areas, the percentage was lower, ranging from 0% to 27.2%. In response to the question, "Has the number of illnesses in the household decreased?" there were several positive responses in areas such as Geita (50.0%), Kigoma (42.8%), Morogoro (45.4%), and Songwe (57.1%); some areas had more positive responses, while in others such as Shinyanga (14.2%), the response was low. Mtwara had a high response rate of 57.1% to the question, "Has the number of HIV-positive people in the village decreased?," while in other regions, the response rates varied from 14 to 36%.

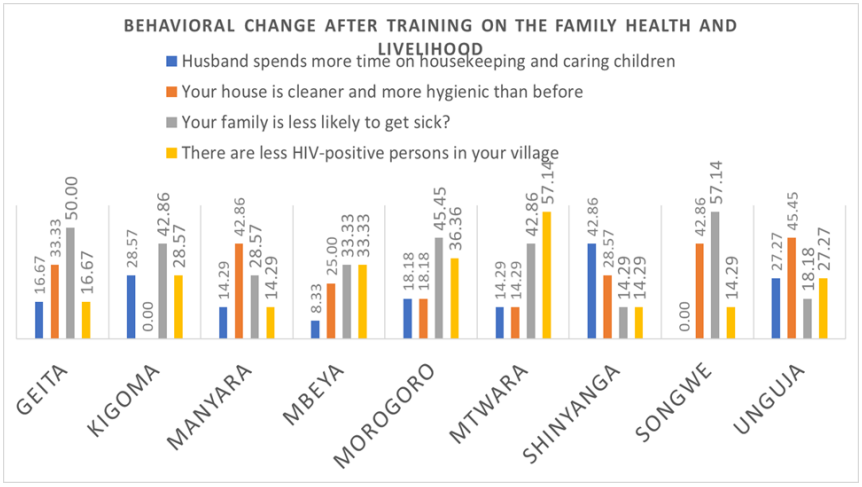


Figure 5- 5. Behavioral Changes after the training (2)

- The participation of women in decision-making and politics: The role of women in household decision-making and community politics is increasing; however, households remain led by men.

6. Proposed Directions for Cooperation in TANRICE 3

6-1. MATI-Related Operational Funding

6-1-1. Funds Related to the Office of the President

At present, the Tanzanian government emphasizes one government, and when multiple ministries are involved in a single matter, the parties involved must meet and discuss the matter in advance.

For example, the Ministry of Agriculture is responsible for securing the necessary budget for implementing TANRICE 3. However, if cooperation with regions and districts (especially in the contribution of funds) is necessary, the Ministry of Agriculture, local governments and the Presidents' Office, which has jurisdiction over local governments (regional secretariat, district government secretariat, and district government office should be involved. The three parties involved must consult with JICA.

Prior to this consultation, it was crucial to identify whether the project aligns with the high-priority area of the local government (e.g., the operation of an IS for irrigated rice cultivation). Understanding the priorities of local governments are crucial because they prioritize and disburse the limited funds allocated by the central government to projects that are necessary for the local area. If a project is deemed to have a high priority in a region, the local government may provide partial funding (approximately 20% of the project) based on discussions among the three parties mentioned above. Discussions on how this interagency cooperation can be best conducted are currently underway in interagency exchanges.

6-1-2. Utilization of International Organizations

Our team visited the WFP, met the person-in-charge, and discussed the possibility of collaboration. Consequently, the following points must be considered and utilized:

- WFP is not an organizational structure that provides funding to implement projects.
- WFP can implement projects when:

1） Funding is provided by the government, private sector, or NGOs.

2） Alternatively, there is a mechanism by which the WFP can work with the government, private sector, NGOs, or JICA to submit a proposal to the World Bank or other donors. Once the proposal has been approved and the project is ready to proceed, experts are recruited to assist the project.

- The following are some representative projects currently being implemented in Tanzania:

1） The Small Framers Unit in the WFP office in Tanzania is implementing six projects. Funds were provided by the Tanzanian government and other private sources. Private-sector funders from the government and others include MasterCard, Irish Aid, and KOICA (KOICA has high flexibility).

2） The target crops for this project are maize, sorghum, soybeans, sunflowers, and horticultural crops (e.g., tomatoes, avocados, and onions).

3） The implementation of this project has been outsourced to an NGO in Tanzania. We may also seek the cooperation of government agencies.

- The largest financial cooperation for the entire WFP was from the U.S., which provided 25% of the total funds.

6-1-3. Measures to increase own funds (income) in each MATI

- KATC produces and sells high-quality seeds.
- Produce and market high-quality crops that exploit the regional characteristics of each MATI (e.g., climate, soil, water conditions, cultivatable area, and access to markets).

6-1-4. Utilization of Existing Training Packages

A training package for rice cultivation was developed based on a series of previous collaborations at the KATC. The technologies covered in the package included 42 items.

Several technical packages on rice cultivation technologies have been developed and published in Tanzania, not only by the KATC, but their content is approximately the same. We must promote the use of TG groups that specialize in actual training and not only knowledge. Therefore, public relations activities for relevant parties and the enhancement of training materials are necessary.

In addition, training expenses must be secured to sustain training. The following three methods can be used to secure training funds:

1) Delivering training services entrusted by other donors, NGOs, or Utilizing budget of local governments

The number of current irrigation projects is increasing compared to the pa. .These irrigation projects include a soft component that corresponds to technical assistance such as farming guidance and management of irrigators' association. NGOs often have funds but not techniques. Undertaking the technical part of the project is possible. With decentralization, regions can use their funds based on their agricultural development plans. Development budgets such as the District Agricultural Development Grant, Agricultural Extension Grant, and Agricultural Capacity Building Grant were allocated. This method could also be used to train farmers. To be implemented, the plan must be adopted in the year before the year of implementation and included in the agricultural development plan for that year. However, according to the DAICO office in the Moshi Rural Region, although decentralization is progressing, budgets for the agricultural sector are limited. Therefore, implementing our own agricultural projects is difficult. Currently, government and NGO projects are expected. To secure a budget for special activities, the project must be adopted by the District Agricultural Development Plan (DADP) the year before the budget is needed. To secure a budget, it is necessary to have an understanding of the district administration and local influential individuals for various training programs.

2) Access to bank financing

Currently, the agricultural financial institutions of Tanzania consist of the Cooperative and Rural Development Bank (CRDB), National Commercial Bank, Tanzania Investment Bank, and Tanzania Development Finance Company banks. These banks are regulated and supervised by the central bank, the Bank of Tanzania. While all these banks lend to the agricultural sector, the bulk of rural financing is provided by the CRDB, which is accountable for providing short- and long-term loans to farmers through the cooperative. Its loans are heavily channeled to specific sectors, such as agricultural distribution, rural transport, agricultural mechanization, and the production of crops for export. In 2015, TADB, established as a government development finance institution, officially began banking operations, targeting the entire agricultural value chain, including the processing industry. Furthermore, private banks, which are not necessarily public banks, are

growing. Private banks are particularly sensitive to farming techniques used to collect profits. As an investment, banks may ask MATI to provide farmers with good training. In addition, MATI cannot borrow directly from these banks, but farmer organizations can. One idea would be to have a portion of the loans used for training needed by the organizations of farmers.

3) Partnerships with private contractors

The commercialization of rice is also progressing in Tanzania, primarily in irrigated areas. Private companies engage in both plantation and contract production. The trend of private companies in cash crops is expanding, albeit gradually. In addition to producer farmers, private companies involved in the rice market (e.g., middlepersons who buy from farmers door-to-door, collectors, millers and processors, and transporters to the wholesale market) are beginning to play an active role in the private market. We believe that incorporating training directly related to private-sector profits will make obtaining private funding more accessible. This may be more sustainable than relying on other donors or NGOs.

6-2. ICT technologies and products to be introduced on a trial basis

6-2-1. Proposal of "rainfed agriculture" x "satellite data utilization" by PASCO Corporation

In order to confirm the actual status of "JJAgri," a service using satellite images, we also interviewed Pasco Corporation, which provides satellite image-related services in Japan. JJAgri is a joint JICA/JAXA service that aims to provide services that meet the needs of multiple fields, not only agriculture, and is currently being developed by the parties involved.

Therefore, we exchanged opinions with PASCO representatives several times on what kind of services using satellite images are required as of 2022. We discussed the following points: 1) land measurement techniques should be divided between satellite imagery, which is suitable for large-scale land evaluation, and small- to medium-scale drone use; 2) the scope of support tends to be expanding to support rice farmers in rainfed and low-marsh areas, and it is good to focus on water use in combination with topographical information and weather information; and 3) the use of satellite imagery for agricultural insurance evaluation is a good example of the use of satellite imagery for agricultural insurance. PASCO proposed a service to help evaluate the potential of rice cultivation in rainfed and lowland areas by combining multiple remote sensing information into a "map of proposed depressed areas suitable for reservoir use.

This service combines "water area data" from SAR (Synthetic Aperture Radar) images, which can be used to identify water areas, "flooded area data" from topographic data (DEM) acquired from satellite images, and "precipitation data" for the land, and overlaps them to set criteria to identify depressions that can be used for rainfed agriculture, or rainfed The proposal is to select land suitable for rainfed rice cultivation in a depression that can be used for rainfed agriculture, i.e., rainfed lowland rice cultivation.

In response to this proposal, we responded that it would be desirable to first create a sample data set using actual rainfed lowland rice cultivation land as the criteria, and then test it for evaluation in a wide range of areas to be covered in future technical cooperation projects. In the future, it will be necessary to conduct tests in actual rainfed lowland rice land and incorporate the process into specific technologies and services, such as the scale at which data sets and criteria should be created and the surrounding areas evaluated, and it is expected that a

cooperative system with TANRICE 3 and others will be established.

6-2-2. Creation of Digital Map Information by Drone Aerial Photography

As a trial introduction test of ICT technology that can be used in actual fields during the implementation of ToT for agricultural machinery, we attempted to create data such as orthoimages as digital map information using a small drone. In recent years, multicopper drones, a type of unmanned aerial vehicle, have become available at relatively low cost. In the Japanese agricultural machinery market, large drones for spraying agricultural chemicals are generally sold, but the target of this project is a relatively small drone for aerial photography. In recent years, there are many products that can fly stably in the air even if they are small, and users can learn to operate them in a relatively short time. For aerial photography, the on-board camera can take video and photographs from a height of 100 meters or more, although there are upper limits according to the laws of each country. Furthermore, by using multiple photos taken continuously over a field, orthoimages of irrigated areas can be created and used in GIS software.

In this trial introduction test, a flight plan was created, actual aerial photography was conducted, orthoimages and DSM (digital surface height data) were created using the obtained photographic data, and examples of how these data can be used were presented to the ToT participants.

<Methods>

The drone used in this study was a DJI Mavic2pro. This drone has the same photographic functions as the company's Phantom series, which has been commonly used for aerial photography for several years, and is foldable, making it easy to use for field operations. Because of the strong restrictions on drone use in Tanzania, and the time and expense involved in obtaining a drone license for Japanese nationals, ToT asked a private contractor who conducts aerial photography operations in Tanzania's national parks and other areas to perform the flight operations for us. However, the flight plan for the creation of the desired orthoimagery and DSM was done by us (Figure 6-1). The flight plan was created and flight instructions were given to the aircraft using the DJI GS Pro iPad app. The target area was about 100 ha of land in the eastern part of the Mombo IS. This size of land required three batteries for the Mavic2pro.

Approximately 1000 images were acquired during this aerial photography. These were processed using “OpenDronMap”, an image analysis software, to create orthoimages (Figure 6-2) and DSM (Figure 6-3). Note that since accurate latitude and longitude information of the land could not be obtained during the creation of the orthoimages in the Mombo irrigation area, no correction process was performed to improve accuracy using ground reference points (GCPs).

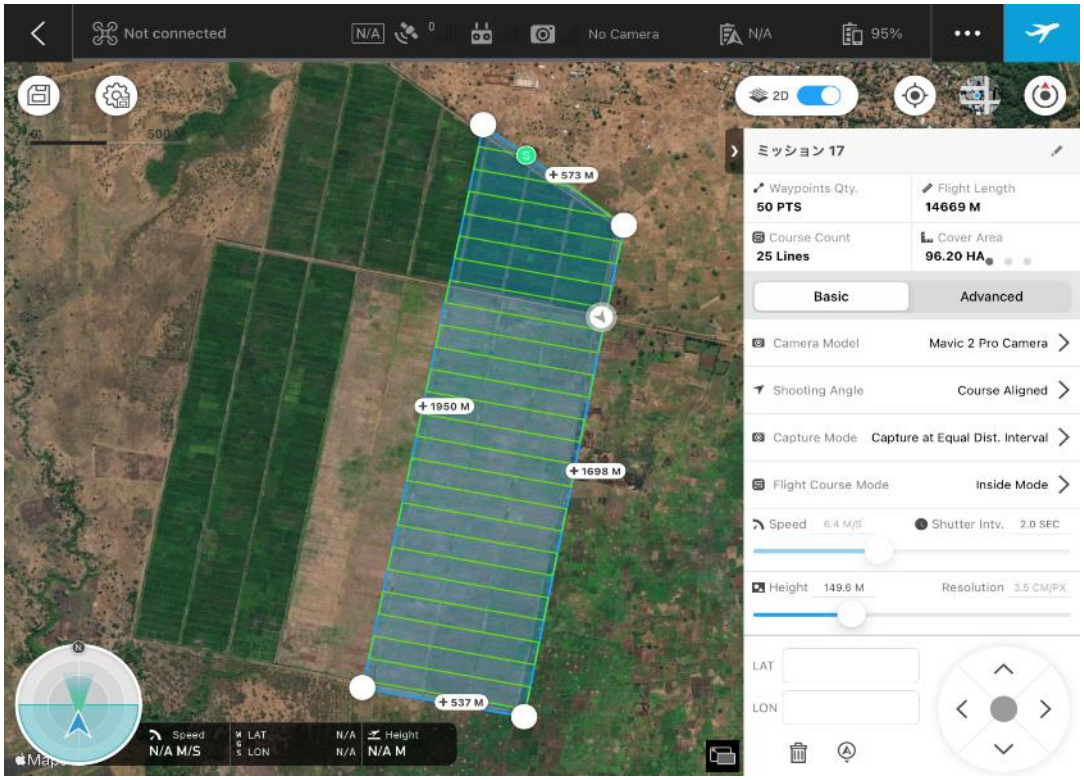


Figure 6- 1. Flight planning screen with DJI GS Pro

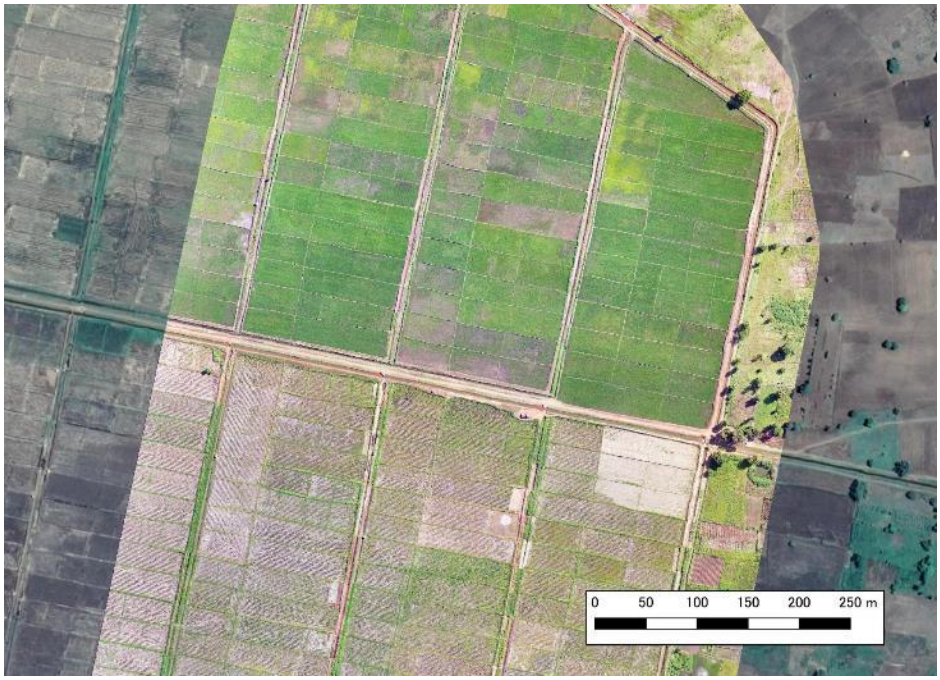


Figure 6- 22. Ortho image created in this test
(Displayed on GIS software, QGIS. The background is Google Earth)

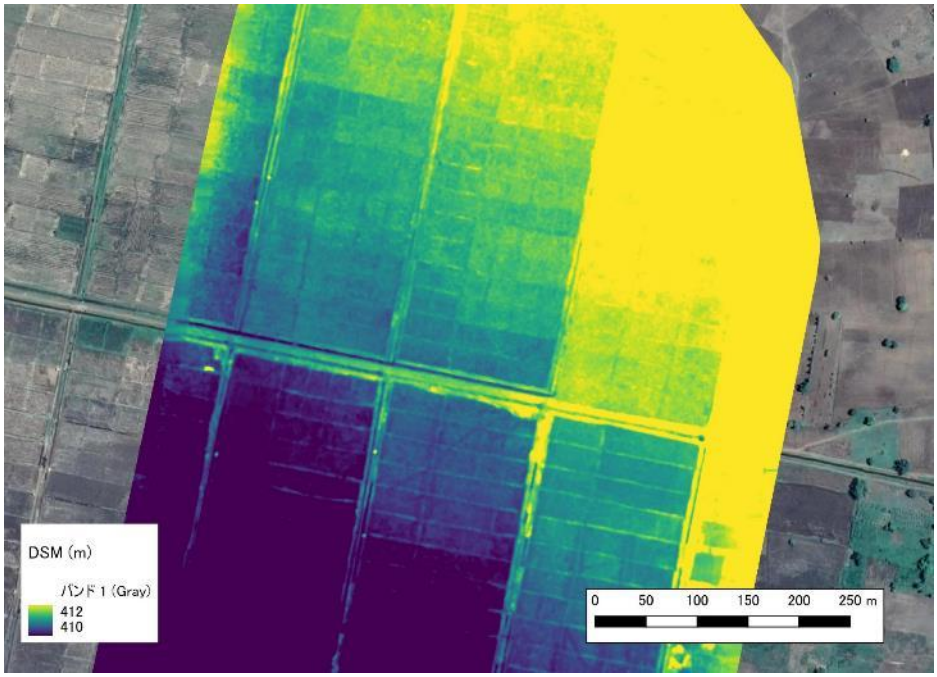


Figure 6- 3. Example of DSM display created in this study
(The method is the same as above. (The same method is used as above, but the area between 410m and 412m is highlighted on the data to show the difference in height.)

<How to use the information obtained>

Google Earth Pro is a simple way to use satellite imagery in the region, and was also used for the background on the GIS software in this case, but the orthoimages created by the drone can be acquired at the time desired by the user at a finer resolution without being affected by clouds, unlike satellite imagery (Figure 6-4). 5). In this case, we used a photograph taken from a height of approximately 150 m above the ground surface, and the GSD (Ground Sampling Distance, or ground sample distance, refers to the distance between pixel centers) on OpenDronMap was 10.0 cm. The GSD can be set according to the drone's sensor specifications and the height at which the drone takes aerial photographs, as smaller and finer resolution data can also be acquired.

Figure 6- 44. Comparison of ortho image (left) and Google Earth image (right)

If polygons are created along each field in the GIS software, they can be used to measure the field area more accurately than the method using GPS alone. In addition, although the unit of measurement for DSM in GIS software is meters, decimal points are also displayed, and responses in cm can also be determined. The obtained DSM information can also be used to evaluate the unevenness of the field. It is believed that not only the undulations of the land, but also the differences in grass height of rice plants within a field can be discriminated, and there is a possibility that this information can be used to evaluate specific diseases and pests (Figure 6-6).

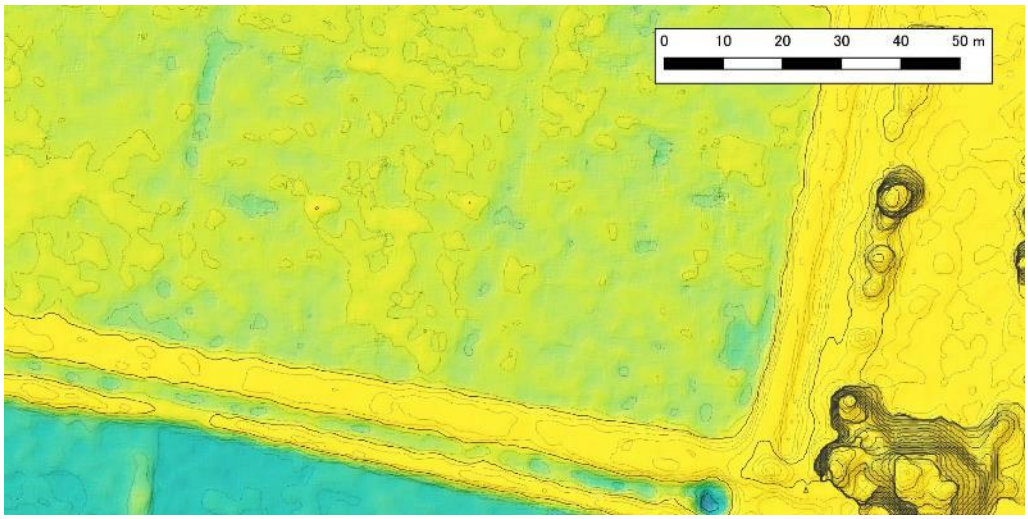


Figure 6- 5. Enlarged image of Figure 4.
(DSM of the area of growing rice on the north side of the canal, where the unevenness of grass height can be identified).

National Agriculture and Food Research Organization (NARO) has published a "Manual for Field Measurement Using a Drone," which can be used as a reference to determine where the soil is high and where it should be moved during leveling work (Figure 6-6).

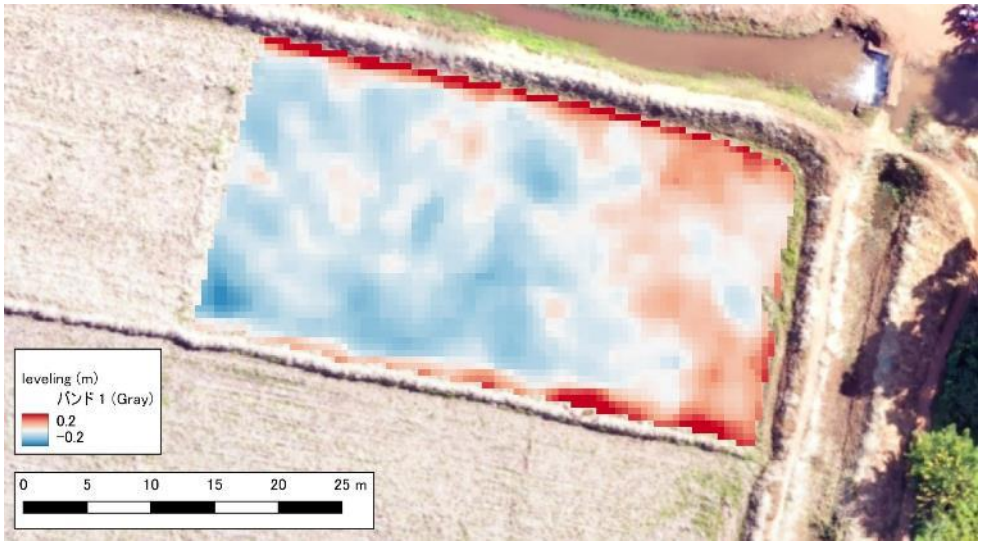


Figure 6- 6. Unevenness information created with reference to the manual of the National Agricultural Research Institute
(The land was plowed only once in advance to provide practical guidance on field maintenance in ToT. Red is high and blue is low. Units in the legend are in meters (m), but the difference in height within the field is about 10 cm)

The introduction of the technology in the field was highly appreciated by the farm machinery TGs from each MATI at the ToT, and many questions were asked during the drone aerial photography. Some MATIs are planning to add the use of drones in irrigation to their lectures and are in the process of searching for materials on specific technologies, so they showed great interest in the aerial photography and data preparation methods. As mentioned above, Tanzania has strong drone regulations, and aerial photography requires a license holder. However, the processing of aerial photography, including the creation of orthoimages using OpenDronMap and other software, and display and analysis using QGIS and other GIS software, is considered sufficient for the content of the MATI lecture.

The accuracy of the obtained data needs to be verified in the future. The accuracy of field data collection will increase as the scale of data collection decreases in the order of satellite imagery, drone use, and actual surveying work, so it will be necessary to separate the two according to the objective.

6-2-3. Drone Regulations in Tanzania

In general, each country has its own laws and regulations regarding the regulation and operation of drones, with some countries placing more emphasis on security and therefore imposing stricter restrictions, while others are late in responding to new technologies and do not have sufficient laws in place. In this context, Tanzania's drone laws are strictly regulated by THE CIVIL AVIATION (REMOTELY PILOTED AIRCRAFT SYSTEMS) REGULATIONS, 2018.

According to this Regulation, drones will be included in RPAS (Remotely Piloted Aircraft Systems), and RPAS will be classified and operated in three classes and three categories according to weight and use RPAS will be operated in three classes and three categories according to weight and use.

Class

1: Weights less than 5 kilograms, including payload carried by RPAS

2: Weights over 5 kilograms but less than 25 kilograms, including payloads carried by RPAS.

3: Weight over 25 kilograms including payload carried by RPAS

(In addition, some operations have a treatment for Filming Clues, and the registration fee seems to be different.)

Categories

A: Used for recreational and sporting purposes only

B: Used for private activities except recreational and sporting purposes

C: Used for commercial activities

In addition, only those who meet the following conditions are eligible to own RPAS

(a) Tanzanian nationals

(b) A person residing within the United Republic of Tanzania

(c) A company registered in the United Republic of Tanzania

(d) The Government of the United Republic of Tanzania.

Therefore, in the case of aerial photography operations such as those conducted in this study, it is considered to fall under Class 1 and Category C. If KATC and MATI operate drones to conduct aerial photography

operations, they will meet the requirements for RPAS ownership, so they must first establish specifications for aerial photography operations when procuring drones, and then establish the appropriate specifications within their organization. Therefore, in procuring a drone, it is necessary to first establish specifications that will allow the drone to withstand aerial photography operations, and then to go through the process of having the appropriate personnel within the organization obtain a license. Alternatively, as in this case, the aerial photography work could be done by an individual or contractor who already has a license, which would be less complicated.

Information on the above regulations and licenses can be obtained from TCAA (Tanzania Civil Aviation Authority). The pilot licensing process includes the following steps

(1) Attend drone pilot training provided by the Tanzania Civil Aviation Authority (TCAA).

(2) Upon completion of the training, apply for a license from the TCAA.

(3) Pay a fee and undergo an examination.

In addition, the method of obtaining an aircraft license includes the following steps

(1) Prepare application documents including detailed aircraft specifications

(2) Submit the application documents to TCAA for review

(3) Pay the fee and obtain the license.

The costs for obtaining a license can be found on the TCAA website and related documents, but the costs for each class are different. For example, the registration fee ranges from US$100 to US$300 per class, and the operation permit fee ranges from US$100 to US$1,000 per class and objective. It is necessary to check with the TCAA to determine how much the fee will cost for the intended operation.

Penalties for violations include trespassing in operational rules or restricted areas and flying without a permit. Penalties include fines, seizure of the aircraft, and revocation of the license. The time required to obtain a license varies depending on the preparation of the application documents and the status of the examination, but it is generally believed to take from several weeks to several months.

As for actual operations, in the case of this research project, we asked a Tanzanian who owned a license to perform flight operations, and it seemed that if he had acquired sufficient knowledge and experience with drones and held a license, he could perform flight operations in a flexible manner. For example, the above-mentioned Regulation sets a no-fly zone, such as prohibiting flights within 10 km of an airport, and as long as this is observed, actual aerial drone photography operations seem to be conducted flexibly and frequently. On the other hand, as with drone operations in other countries, we could not see much room for intrusion as to whether the procedures detailed in the Regulation are always being implemented.

Not only in Tanzania, but in some cases, although the system is strictly enforced, the procedures may be too complicated to operate, and in such cases, it is advisable to check the situation on the ground with local drone aerial photography service providers as well.

7. Recommendations for Medium- and Long-term JICA Supporting Activities

At the end of TANRICE 3, a certain level of cooperative effectiveness for MATI will be achieved. This is particularly true for MATI tutors.

1. Targets of Cooperation

If JICA continues to cooperate in the promotion of rice cultivation in Tanzania, rice cultivation in rainfed lowland areas, which account for 70% of the rice cultivation area in Tanzania, requires technological development. In addition, the dissemination of rice cultivation technologies among farmers is crucial. Therefore, providing support and cooperation to research institutes, such as TARI and the departments responsible for technology dissemination to farmers, may be necessary.

2. Irrigation Facility Renewal Projects

Tanzania has 2,415 ISs, 1,280 of which have been upgraded to modern facilities (NIMP 2018: National Irrigation Master Plan 2018). Despite high expectations for irrigation development in response to drought and flooding in the region, there have been several incomplete projects because of insufficient funds and techniques, resulting in limited improvements in irrigation efficiency and agricultural production. Japan successfully implemented and completed the Small-Scale Irrigation Development Project (SSIDP), a yen loan project that involved the rehabilitation of 51,778 ha of irrigated land at 119 locations. The project with TANCAID I and II greatly contributed to the capacity building of Tanzanian irrigation officials and agriculture in the target areas. Considering the budget constraints faced by the Tanzanian government in irrigation development, it is worth reconsidering the further rehabilitation of irrigation facilities through financial assistance, such as yen loans and grant aid. This initiative aims to expedite the promotion of rice cultivation within a short time frame and make a meaningful contribution to the agricultural sector.

3. Agricultural Mechanization of Rainfed Lowland Areas

Irrigated rice fields have undergone mechanization, initially with the introduction of power tillers and tractors, followed by using combine harvesters. These advancements have significantly enhanced labor productivity in activities such as land preparation, plowing, harvesting, and threshing. Consequently, mechanization has intensified production, resulting in increased yields and household income. However, rainfed rice cultivation relies heavily on rainfall and is susceptible to annual weather fluctuations, making production unstable. This unfavorable environment poses challenges for agricultural mechanization in rainfed rice farming. Therefore, it is crucial to design appropriate mechanization interventions that consider various factors, such as farming systems and farm size, labor dynamics, the income structure of farmers, and other socioeconomic aspects. To achieve this, it is advisable to prioritize research efforts aimed at gaining a better understanding of the demand for mechanization services. By identifying fundamental rice cultivation techniques suitable for farmers in rainfed rice fields and promoting the use of affordable machines, such as ox plowing, seeding machines, and weeding machines, we can effectively address the need for mechanization according to specific local conditions.