JICA Data Collection Survey on Promotion of Advanced Agricultural Technologies in Sub-Saharan Africa

Final Report

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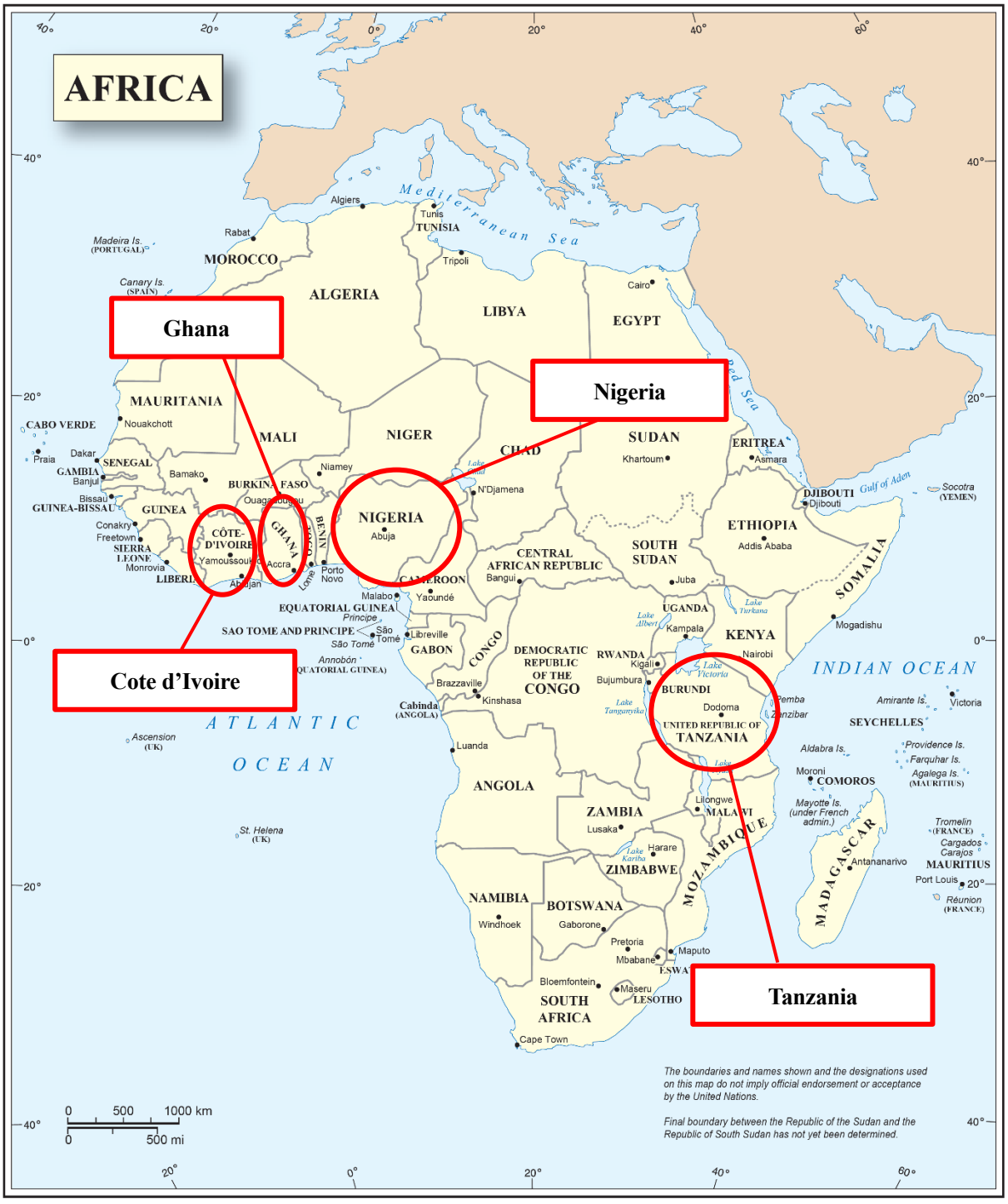

Source: United Nations Geospatial Information Section website

Map of countries surveyed

Table of Contents

Abbreviations (common)

Abbreviation	Full name
AFICAT	Africa Field Innovation Centre for Agricultural Technology
AfDB	African Development Bank
AGRA	Alliance for a Green Revolution in Africa
AIPA	Agriculture Innovation Platform in Africa
AKTC	Agricultural Knowledge and Training Centre
AU	African Union
AUC	African Union Commission
BAS	Basic seed
BS	Breeder seed
CARD	Coalition for African Rice Development
CP	Counterpart
CS	Certified seed
DAP	Diammonium phosphate
ECOWAS	Economic Community of West African States
FBO	Farmer-Based Organization
FS	Foundation seed
GART	Golden Valley Agricultural Research Trust
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit
Ha	Hectare
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movements Organics International
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
JiPFA	JICA Platform for Food and Agriculture
JIRCAS	Japan International Research Center for Agricultural Sciences
KPI	Key performance indicator
MDGs	Millennium Development Goals
MFB	Microfinance bank

Abbreviation	Full name
MFI	Microfinance institute
MOP	Muriate of potash
NGO	Non-governmental organization
NRDS	National Rice Development Strategy
ODA	Official development assistance
PAMA	Promotion of Agricultural Mechanization for Africa
PBS	Pre-basic seed
PDM	Project Design Matrix
PFI	Participating financial institution
PHRD	Policy and Human Resources Development Fund
PTO	Power take-off
QDS	Quality-declared seed
SDGs	Sustainable development goals
SHEP	Smallholder Horticulture Empowerment and Promotion
SMS	Short message service
SSA	Sub-Saharan Africa
TICAD	Tokyo International Conference on African Development
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VC	Value chain

Abbreviations (Ghana)

Abbreviation	Full name
AESD	Agricultural Engineering Services Directorate
AMSEC	Agricultural Mechanization Service Enterprise Center
CSIR	Council for Scientific and Industrial Research
CSIR-CRI	Crop Research Institute
CSIR-SRI	Soil Research Institute
DCS	Directorate of Crop Service
EPA	Environmental Protection Agency
GASIP	The Ghana Agricultural Sector Investment Programme
GIDA	Ghana Irrigation Development Authority
GRIP	Ghana Rice Production Improvement Project

Abbreviation	Full name
KIS	Kpong Irrigation Scheme
KNUST	Kwame Nkumah University of Science and Technology
MoFA	Ministry of Food and Agriculture
PPRSD	Plant Protection & Regulatory Services Directorate
PPRSD-GSID	Plant Protection & Regulatory Services Directorate - Ghana Seed Inspection and Certification Division
PPRSD-PFRD	Plant Protection & Regulatory Services Directorate - Plant Quarantine Services and Pesticides and Fertilizer Regulatory Division
REP	Rural Enterprise Programme

Abbreviations (Nigeria)

Abbreviation	Full name
ABP	Anchor Borrowers' Programme
AMMOTRAC	Agricultural Mechanics and Machinery Operators Training Center
ATA	Agriculture Transformation Agenda
BOA	Bank of Agriculture
BOI	Bank of Industry
CBN	Central Bank of Nigeria
FCMB	First City Monument Bank
FCT	Federal Capital Territory
FCTA	Federal Capital Territory Administration
FDA	Federal Department of Agriculture
FISSD	Farm Inputs Support Services Department
FMARD	Federal Ministry of Agriculture and Rural Development
FMWR	Federal Ministry of Water Resource
NADP	Nasarawa Agricultural Development Program
NAERLS	National Agricultural Extension and Research Liaison Services
NAMEL	Nigerian Agricultural Mechanization and Equipment Leasing Company
NASC	National Agriculture Seeds Council
NCAM	National Center for Agricultural Mechanization
NCRI	National Cereal Research Institute
NIAE	Nigeria Institution of Agricultural Engineers
RBDA	River Basin Development Authority

Abbreviation	Full name
RIFAN	Rice Farmers Association of Nigeria
RIMAN	Rice Millers Association of Nigeria
RIPAN	Rice Processors Association of Nigeria
TOHFAN	Tractor Owners and Hiring Facilities Association of Nigeria
Triming	Transforming Irrigation Management in Nigeria

Abbreviations (Tanzania)

Abbreviation	Full name
ASA	Agriculture Seed Authority
AGITF	Agricultural Inputs Trust Fund
ASDP	Agricultural Sector Development Programme
BPS	Bulk Procurement System
CAMARTEC	Center for Agricultural Mechanization and Rural Technology
KADC	Kilimanjaro Agricultural Development Center
KADP	Kilimanjaro Agricultural Development Project
KATC	Kilimanjaro Agricultural Training Center
LOMIA	Lower Moshi Irrigators Association
MATI	Ministry of Agriculture Training Institute
NBS	National Bureau of Statistics
PASS	Private Agricultural Sector Support
SIDO	Small Industries Development Organization
TAMS	Tanzania Agricultural Mechanization Strategy
TARI	Tanzania Agricultural Research Institute
TANRICE2	Project for Supporting Rice Industry Development in Tanzania
TANRICE2.5	Information Collection and Confirmation Survey for Rice Promotion and Strengthening of Extension and Training Systems
TANRICE3	Project for Strengthening Capacities of Stakeholders of Rice Industry
TBS	Tanzania Bureau of Standard
TOAM	Tanzania Organic Agriculture Movement
TOSCI	Tanzania Official Seed Certification Institute
VFP	Victoria Finance PLC

Abbreviations (Côte d'Ivoire)

Abbreviation	Full name
2PAI-Bélier	Le Projet de Pôle Agro-Industriel dans la région du Bélier
ADERIZ	Agence pour le Developpement de la filière RIZ
ANADER	Agence Nationale d'Appui au Développement Rural
CFMAG	Le Centre de Formation à la Mécanisation Agricole de Grand-Lahou
CNRA	Centre National de Recherche Agronomique
CUECDA	Cellule Universitaire d'Expertise et de Conseil pour le Developpement Agricole
DMEME	Direction de la. Maîtrise de l'eau dans le domaine agricole et de la. Modernisation des. Exploitations
FAD	Le Fonds Africain de Développement
INPHB	Institut National Polytechnique Félix Houphouët-Boigny
MINADER	Ministère de l'Agriculture et du Développement Rural
ONDR	Office National de Développement de la Riziculture
PEMA	Petites et Moyennes Entreprises Agricoles
PNIA	Programme National d'Investissement Agricole
PRORIL	Projet de Promotion du Riz Local en République de Côte d'Ivoire
SNDR	La Stratégie Nationale de Développement de la filière Riz
UNACOOPEC	Union Nationale des Coopératives d'épargne et de Crédit

Exchange rate

Regarding exchange rate in the text, the rate of the month in which the field survey was completed is applied, as shown below.

< Chapter 3 Ghana > (as of April 2021)
USD1 (U.S. dollar) = 110.209000 yen
EUR1 (Euro) = 129.366000 yen
GHS 1 (Ghana cedi) = 19.119000 yen

< Chapter 4 Nigeria > (as of June 2021)
USD1 (U.S. dollar) = 109.811000 yen
EUR1 (Euro) = 134.026000 yen
NGN1 (Nigeria naira) = 0.268330 yen

< Chapter 5 Tanzania > (as of July 2021)
USD1 (U.S. dollar) = 110.552000 yen
EUR1 (Euro) = 131.632000 yen
TZS1 (Tanzanian shilling) = 0.047890 yen

< Chapter 6 Cote d'Ivoire > (as of September 2021)
USD1 (U.S. dollar) = 109.862000 yen
EUR1 (Euro) = 129.628000 yen
XOF1 (CFA franc) = 0.197620 yen

Summary

1. Overview of the Survey

1.1. Background of the survey

The African Business Council's Agriculture Working Group introduced the Agriculture Innovation Platform in Africa (AIPA) during the Plenary Session 3 Public-Private Business Dialogue of the Seventh Tokyo International Conference on African Development (TICAD7) held in August 2019. In the AIPA, the introduction of advanced agricultural technologies has been raised as one of the priority actions to develop the agriculture sector in Sub-Saharan Africa (SSA). Japanese companies are expected to be encouraged to participate, invest, and provide their value in SSA, and the Japanese Government set forth "support this through the TICAD initiative and policy dialogue."

This survey was conducted to establish the "Africa Field Innovation Centre for Agricultural Technology (AFICAT)" for facilitating the introduction of advanced agricultural technologies in SSA. In AFICAT, "the utilization of agricultural machinery" was set as the major component of advanced agricultural technology.

JICA conducted the "Data Collection Survey on Agricultural Mechanization in Sub-Saharan Africa in Collaboration with Japanese Private Sector" (hereinafter referred to as "the preceding survey") from February to September 2019. The preceding survey revealed that for Japanese companies to introduce advanced agricultural technologies, particularly agricultural machinery, exhibiting and demonstrating agricultural machinery at model fields would be beneficial. To realize this, issues and required actions that should be addressed by the public and private sectors were summarized in the final report as recommendations.

The results were discussed at various occasions such as the JiPFA (JICA Platform for Food and Agriculture), the "Agriculture Working Group of the African Business Council" organized by the Japanese Government, and the "Global Food Value Chain Public-Private Council" organized by the Ministry of Agriculture, Forestry and Fisheries. Subsequently, as mentioned above, the plan of AFICAT was announced to the African leaders and other participating representatives at TICAD7 as one of Japan's cooperative development efforts in the field of agriculture within SSA.

1.2. Purpose of the survey

The purpose of the survey is to compile information on the establishment of AFICAT, a center for exhibition, demonstration, human resource development, and innovation to promote advanced technologies and agricultural mechanization in SSA and contribute to the improvement of agricultural productivity and quality of agricultural products. The center will also serve as a foothold for Japanese manufacturers to promote their business in SSA, assuming that the center will be promoted by the public and private sectors of Japan and Africa.

1.3. Target countries and periods of field survey

The survey is being conducted from April 2020 to March 2022 with the following schedule of field survey:

Country	Field survey period
Ghana	March 11 to April 5, 2021
Nigeria	May 14 to June 7, 2021
Tanzania	July 3 to July 18, 2021
Cote d'Ivoire	September 11 to 26, 2021

For the establishment of AFICAT, five countries, namely Ghana, Nigeria, Tanzania, Cote d'Ivoire, and Kenya were selected as the priority countries. As a result of coordination between the Kenyan government and JICA, however, Kenya was excluded from the survey. Therefore, field surveys were conducted in four countries.

2. Japanese Companies Related to Agricultural Machinery and Materials

2.1. Current situation and challenges of business in SSA for Japanese Companies related to agricultural machinery and materials

Among 249 agricultural machinery manufacturing companies, the following four companies account for 80% of the total shipment value: Kubota Corporation (Kubota), Yanmar Holdings Co. Ltd. (Yanmar), Iseki & Co. Ltd. (Iseki), and Mitsubishi Mahindra Agricultural Machinery Co. Ltd. (Mitsubishi). In this survey, five companies, including these four companies and Satake Corporation (Satake), a major manufacturer of paddy processing machinery, were considered the "major agricultural machinery manufacturers."

In the preceding survey, questionnaires were distributed to 143 companies. The results were collected from 36 companies, and other 76 companies responded via telephone. The table below summarizes the results for these 112 companies. Among them, only 32% companies have sold rice-related machinery overseas and only 15% companies have manufacturing bases overseas. Moreover, only 10% companies intend to enter the SSA market.

Table Overseas sales and manufacturing and intention to enter SSA (112 companies)

			Yes	No	N.A.	Total
Manufacture of rice-related machinery overseas		(Number)	77	30	5	112
		(%)	69	27	4	100
Overseas sales	Overall	(Number)	50	56	6	112
		(%)	45	50	5	100
	Rice-related machinery	(Number)	36	70	6	112
		(%)	32	63	5	100
Overseas manufacturing bases	Overall	(Number)	22	90	0	112
		(%)	20	80	0	100
	Rice-related machinery	(Number)	17	94	1	112
		(%)	15	84	1	100
Intention to enter SSA		(Number)	11	101	-	112
		(%)	10	90	0	100

Source: Preceding survey

Of the 36 companies from which the questionnaires were collected, only 9 (25%) reported having sold their products in SSA. Regarding barriers faced or expected by these companies in expanding their sales

channels to SSA, the most common answer was “low priority in terms of business strategy” (18 companies, 50%), followed by “no or unsuitable distributors or dealers” (16 companies, 44%), “poor security,” “political instability,” “inability to establish after-sales service and maintenance systems,” and “low prices of competitors’ products in SSA” (13 companies each, 36%).

2.2. Results of the survey of Japanese companies related to agricultural machinery and materials

Individual interviews were conducted with 28 companies: 4 major agricultural machinery manufacturers, 14 agricultural machinery manufacturers related to rice and other agricultural products, 4 other companies including material manufacturers, and 6 general trading companies.

2.2.1. Intention to participate in AFICAT and requests regarding countries and regions where AFICAT will be established

The interviewed companies expressed an overall positive interest in the SSA market and high expectations of the establishment of AFICAT. The results of survey in which the companies were asked whether they were interested in participating in AFICAT and points that should be taken into account when considering a proposal to establish AFICAT are summarized below.

(1) Major agricultural machinery manufacturers

They expressed high interest in AFICAT, hoping that it would be operational at the earliest both in East and West Africa, and confirmed their interest in Madagascar, which is associated with high rice production. Meanwhile, they expressed concern regarding the lack of security in Nigeria.

(2) Other agricultural machinery manufacturers

Of the 14 agricultural machinery manufacturers other than major ones interviewed, only 5 expressed their intention to participate in AFICAT. Of the 14, only 3 companies have local agents in SSA, and the remaining 11 have neither agents nor sales experience in SSA.

(3) Agricultural material manufacturers

Of the four companies, two agricultural material manufacturers interviewed expressed interest in joining AFICAT. They also reported willingness to provide their products free of charge.

(4) General trading companies

General trading companies have operation bases in SSA and also invest in agriculture-related companies in various forms. Of the six general trading companies, four expressed interest in participating in AFICAT.

2.2.2. Agricultural machinery and materials granted or lent

Although the intentions regarding granting or lending machinery and materials and dispatching personnel vary across companies, more companies are willing to provide products for small than for large agricultural machinery and agricultural materials than small agricultural machinery. Of the four major agricultural machinery manufacturers, only two clearly stated willingness to provide or lend agricultural machinery free of charge. Meanwhile, over half of the other agricultural machinery manufacturers (8 out of 14) said that they may provide or lend agricultural machinery free of charge. Two agricultural material manufacturers reported that they can provide their products free of charge.

2.2.3. Dispatchment of personnel

Seven of the 18 agricultural machinery manufacturers responded that they could dispatch personnel at their own expense, albeit on short-term trips. Some companies would like to travel, but strongly requested to receive a subsidy of nearly half the cost of the trip. The dispatch of human resources by Japanese companies must be supplemented through the use of remote technologies, such as online meetings from Japan, collaboration with JICA technical cooperation projects implemented in the area, and help from local staff.

3. Current Status of and Issues Related to Agricultural Mechanization in Ghana

3.1. Rice production and related policies

Rice is the second major grain following maize, and the domestic annual rice production doubled from 230,000 tons to 530,000 tons between 2009 and 2018 (in terms of white rice). Meanwhile, domestic rice consumption has been growing rapidly in recent years due to population growth, urbanization, and changes in eating habits, with annual per capita consumption reaching 45.7 kg in 2018, indicating an increase from 25.6 kg in 2009; however, since the domestic production rate is not consistent with the consumption rate, the country must rely on imported rice, which accounted for 61% (2018) of the domestic consumption. In this context, increasing rice self-sufficiency is one of the major challenges faced by the Ghanaian government in terms of food security and foreign exchange.

Formulated in 2009, NRDS sets ambitious targets to increase average paddy yield from 2.7 to 4.0 ton/ha, paddy cultivation area from 118,000 to 375,000 ha, and paddy production from 318,600 to 1.5 million tons between 2008 and 2018. However, the actual results in 2020 indicated that the average paddy yield was 2.88 ton/ha and the paddy cultivation area was only 261,192 ha. Although the paddy production has more than doubled since 2009, reaching 752,300 tons, it remains only half of the target value. Moreover, in 2018, white rice production was 531,000 tons, while the imports were 830,127 tons, indicating that over 60% of the rice consumption relies on imports. In this light, NRDS 2019-2030 is being formulated to promote paddy cultivation and rice self-sufficiency in the future.

3.2. Overview of agricultural mechanization

(1) Rainfed lowlands

In rainfed lowlands, rice is cultivated using stream water flowing from springs and other water sources in the catchment area, in addition to rainfall. In the Ashanti Region, where JICA's Rainfed Rice Project 2 was implemented, rice is cultivated in rainfed lowlands. Here, only 20% of the land preparation work is performed using a power tiller and most of the harvest is completed manually by laborers. The field plots are small, measuring 25 m × 40 m, and the plots are divided into 4 to 8 equal sections with temporary bunds. Smaller plots facilitate manual plowing and leveling works.

Manual puddling
Source: JICA's rainfed rice project 2

(2) Rainfed uplands

Rainfed uplands are mainly distributed from central to northern Ghana. According to AESD, rice is one of the major cereal crops in rainfed upland areas, in addition to maize, sorghum, and millet, and it is produced through manual labor. However, the area and production of rice in the uplands account for only 5% of the total. In particular, the production of rice is more dependent on rainfall than that of other field crops; thus, the future growth of rice production in rainfed uplands is expected to be limited.

(3) Irrigated lands

Mechanization is more prevalent in irrigated areas than in other areas. In the KIS, Weta Irrigation Scheme, and Dawhenya Irrigation Scheme, which were visited by the survey team, tractors and power tillers are used for land preparation works, and combine harvesters are used for harvesting works. However, in all irrigation schemes, the number of agricultural machines is insufficient, and losses due to failure to harvest at the right time have been reported.

Under the conditions of KIS described above, a service provider of combine harvesting would have gross income of GHS 80,000 per season, based on the conditions of approximately 2 ha per day, 5 days per week, 2 months per season, 40 days per season, and 80 ha per season.

Harvesting lodged paddy

Bagging of grains

Most grains are at the milky stage

Harvesting works in the KIS

Source: Survey team

(4) Service providers

Service providers include farmers who own agricultural machinery, people who own agricultural land but are engaged in other businesses (construction, processing, or civil services, among others), and corporations that specialize in their own business. There are few skilled operators, the lack of basic knowledge of the machinery, ignorance of routine inspection, and overzealous operation are some of the major causes of agricultural machinery breakdown.

To promote agricultural mechanization by the private sector, the Ghanian government has been implementing the AMSEC program since 2007, which encourages the establishment of AMSECs. In addition to this, there are some agricultural machinery service providers for farmers.

3.3. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for establishment of AFICAT is proposed by the survey team.

3.3.1. Basic policy for the establishment of AFICAT (draft)

AFICAT will be based in the KIS region, which was the base of the "Project for Enhancing Market-Based Agriculture by Smallholders and Private Sector Linkages in Kpong Irrigation Scheme (MASAPS-KIS Project)" implemented by JICA from January 2016 to July 2021.

In cooperation with the Ghana Rice Production Improvement Project (GRIP), which was scheduled to start in FY2021 by JICA, AFICAT will work closely with GRIP to ensure efficient implementation of exhibitions, verifications, demonstrations, and public relations.

3.3.2. Candidate institutions/locations/schemes for collaboration with AFICAT (draft)

In the irrigated areas, AFICAT will start its activities in KIS areas, where vast irrigated fields have been developed and human resources have been trained. The activities will be expanded to other irrigated areas according to the progress of GRIP and the security status.

Irrigated paddy field in KIS (approx. 2,000 ha)

Chinese combine harvester

Rice mill in KIS

Source: Survey team

3.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

- Many of the major Japanese agricultural machinery manufacturers still do not have local agents or distributors. In such cases, it is necessary to start with the selection of distributors and dealers. Since many Japanese companies pointed out that they lacked information on agents and distributors, AFICAT is expected to provide information on potential agents and distributors as one of its functions.
- In rainfed lowlands, which account for 78.8% of the total rice cultivation area and 71.1% of the total paddy production, there has been little mechanization; however, in irrigated areas, land preparation using tractors and power tillers and harvest using combine harvesters have been mechanized.
- With support from the Brazilian and Czech governments, agricultural machinery manufactured in the respective country is sold with subsidies. For agricultural machinery with similar functions, such as power tillers and tractors, Japanese companies are at a disadvantage in terms of price competition. Meanwhile, medium-sized combine harvesters for paddy harvest may offer more commercial opportunities than power tillers and tractors, because similar products are not available. Such information will also be provided to Japanese companies for their reference when they enter SSA.
- As of March 2021, when the field survey was conducted, most combine harvesters were made in China and Japanese agricultural machinery was not available. Combine harvesters are cheaper than manual harvesting and threshing, and combine harvesters from other countries have proven highly efficient at

the right time of harvest. In Tanzania, many farmers have replaced Chinese products with Japanese combine harvesters. Japanese combine harvesters are preferred because of high efficiency in threshing, low amount of foreign matter such as straw, almost no breakdown during operation, good performance even in wetlands with poor drainage, and high durability of various parts. Although the price of Japanese brands is higher than that of Chinese brands, given on the model, the products are considered worthy of the price. Similar outcomes are expected in Ghana. In this case, AFICAT will be able to support verifications and demonstrations as required.

4. Current Status of and Issues Related to Agricultural Mechanization in Nigeria

4.1. Rice production and related polices

Domestic rice production increased from 2.37 million tons per year to 5.6 million tons (white rice equivalent) between 2009 and 2018, and Nigeria surpassed Madagascar to become the largest rice producer in SSA. Rice consumption in the country has grown more rapidly than production due to recent population growth, urbanization, and changes in eating habits, with annual per capita consumption reaching 32.9 kg in 2018 from 22.8 kg in 2009. In 2019, the country imported 845,000 tons of rice, which is only 13% of the total domestic rice consumption; however, due to the large domestic market, rice self-sufficiency is one of the main challenges for the Nigerian government in terms of ensuring food security and securing foreign currency.

NRDS was formulated in 2009 and the NRDS Phase 2 (NRDS2) in 2020. The goal of NRDS was to increase paddy production from 3.4 million tons in 2007 to 12.85 million tons by 2018. To increase the yield from 1.5–3.5 ton/ha at that time to 2–8 ton/ha according to field conditions, NRDS planned to improve the extension system, establish modern rice processing facilities, rehabilitate old irrigation schemes, mechanize rice production and processing through public–private partnerships, and compensate the minimum price of rice. In 2019, rice production doubled from the value in 2008, reaching 8.44 million tons, although only 66% of the target was achieved.

4.2. Overview of agricultural mechanization

Tractors, disk plows, disk harrows, and ridgers are the main agricultural machinery used in Nigeria. All of these are mainly used for land preparation for upland crops as well as for rice production in rainfed upland crops (upland rice) or plowing and harrowing in dry irrigated land conditions.

The estimated use of tractors in Nigeria is less than 10%. It is estimated that nearly 100,000 tractors and work equipment are required to work at the right time based on the current farmland area; however, only around 7,000 tractors are currently in operation. Delays in work due to the lack of farm machinery decrease productivity and lead to grain losses.

Plowing with a disc plow (left) and harrowing with a disc harrow (right)
Source: Provided by NCAM

Farmers own several tens of hectares or more of farmland and work with service providers or use their own farm machinery. Some farmers outsource only plows to a service provider and use a hoe for puddling and leveling works after rainfall or irrigation.

(1) Northern zone

In the northern zone, even though annual rainfall is only 700 mm, Kano and the neighboring states of Jigawa and Sokoto are major rice-growing regions in the country. All these states are home to agricultural areas where two to three rice crops can be grown annually by irrigating from rivers or using groundwater. In the northern part of the country, in addition to large-scale rice cultivation, cassava, groundnut, and maize are grown with the use of agricultural machinery (tractors, disk plows, disk harrows, and ridgers) for the land preparation. However, this is also a poor area, and many small farmers work as laborers for large-scale farmers.

(2) Southern zone

The southern zone is blessed with abundant rainfall throughout the year, although mechanization has not progressed much. This is because the soil is heavy due to high clay and moisture content, and there are many marshy areas without a hardpan where machinery sinks (bogged down). In paddy fields with heavy rainfall and poor drainage, there are many losses due to delays in harvesting and lodged paddy.

(3) Central zone

Most of the central zone has rainfed lowland rice-growing areas. Nasarawa State, adjacent to the east of the capital Abuja, produces about 400,000 tons of rice annually. Upland crops, such as rice and horticultural crops, are planted during the rainy season, from June to August. Rainfall and year-round streams are used to irrigate rainfed rice fields. However, rainfall during the harvest season can lead to lodged paddy and delay harvest.

(4) Service providers

TOHFAN provides agricultural machinery services to farmers and others using 568 tractors and various work equipment (implements). The owners of the farm machinery are independent of TOHFAN and entrust TOHFAN with everything, from tractor maintenance to machinery services, and receive a portion of the sales.

4.3. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team.

4.3.1. Basic policy for the establishment of AFICAT (draft)

Nigeria has the largest population and GDP in SSA, and the need for increasing food production is extremely high. According to some Japanese companies, the size of the market is very attractive, partly because agricultural mechanization in Nigeria is lagging behind compared with that in Tanzania and Ghana. Meanwhile, in Nigeria, due to the impact of COVID-19, field activities were restricted to the certain areas (as of May 2021). In addition, Japanese experts are not allowed to visit areas with the safety risk levels 3 and 4. Although Japanese companies are highly interested in the Nigerian market, many of them are concerned about the lack of security.

Therefore, the basic policy is to initiate AFICAT activities on a small scale and in a feasible manner, focusing on locations that Japanese companies and experts can visit and to gradually expand the activities to other areas in cooperation with the relevant local organizations as the activities progress.

In Nigeria, an advisor on agricultural development has been dispatched to FMARD, and a technical cooperation project on rice seeds is being planned with NCRI as the main C/P. In addition, the possibility of a grant aid project to provide agricultural machinery is being considered. NCRI has six rural stations in Nigeria and provides agricultural machinery services, such as land preparation tractors, to contract farmers (out-growers) who produce seeds. By incorporating AFICAT activities into the JICA technical cooperation project on rice seeds, verifications and demonstrations of Japanese agricultural machinery can be conducted, although activities will be limited to rice production.

4.3.2. Candidate institutions/locations for collaboration with AFICAT (draft)

As the National Rice Desk Officer and the Director of Engineering and Mechanization are assigned in the FDA of FMARD, AFICAT operations can be efficient if FDA serves a contact function for AFICAT (e.g., AFICAT desk). In addition, since an agricultural development advisor has already been dispatched to ABM, which is in charge of post-harvest processing, it is desirable to form a structure in which the advisor takes the lead in rice promotion and agricultural mechanization in cooperation with the Federal Capital Territory Administration (FCTA), Nasarawa state government, NCRI, NCAM, and other related organizations.

FMARD and NCRI are the main government agencies for rice promotion, and FMARD and NCAM are the main government agencies for agricultural mechanization. However, NCRI is located in Niger State and NCAM in Kwara State, which Japanese experts cannot visit as of May 2021. Therefore, AFICAT activities will start from Abuja, where FMARD is located, as well as FCTA and the neighboring Nasarawa State government (specifically, the Agricultural Development Program of each state), which the Japanese experts can visit, and the scope of activities will be expanded as the project progresses and/or the safety risk level improves.

Old machinery shed at the Nasarawa State Agricultural Office in Lafia

Source: Survey team

4.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

✓ Agricultural machinery

- Agricultural mechanization in Nigeria lags behind compared with that in Tanzania and Ghana. Nigeria's area under paddy cultivation and paddy production volume are the largest in SSA, and the market is very large. However, there is a serious concern regarding security, and it is difficult for Japanese experts to

work here. Therefore, AFICAT will conduct verifications and demonstrations in places where Japanese experts can work, and the related organizations will be invited to places where the Japanese experts can visit and conduct activities.

- Agricultural machinery will be imported through a loan from the Brazilian government and will be assembled and sold under soft loans in Nigeria. In some cases, state governments provide subsidies (in the case of the Jigawa State government, subsidies are used to reduce the price by 62–65%), making it difficult for the Japanese companies to sell similar type of agricultural machinery without any financial arrangements in Nigeria. AFICAT can provide information on the types and prices of subsidized agricultural machinery to Japanese companies as a reference when they enter the SSA market.
- In terms of rice production, the level of mechanization for land preparation is not very advanced. Combine harvesters must be introduced with caution due to the possibility of depriving farmers of labor opportunities and possibility of opposition from the community.
- Even major Japanese agricultural machinery manufacturers do not have local agents or dealers, because they have not prioritized Nigeria as their market. It is necessary to start with the selection of distributors and dealers. In interviews, many Japanese companies (44%) pointed out that there is lack of information on distributors and dealers; thus, AFICAT is expected to provide information on potential distributors and dealers as one of its functions.

✓ Rice mills

- Parboiled rice is mainstream in Nigeria. Japanese manufacturers do not produce parboiled rice processing equipment. However, it is possible to produce parboiled rice processing equipment to meet the overseas demand. Large rice milling plants in Nigeria are equipped with parboiled rice processing equipment, and many of the products made in India and China are used for paddy processing (machines that soak, steam, and dry paddy).

5. Current Status of and Issues Related to Agricultural Mechanization in Tanzania

5.1. Rice production and related policies

Rice is the second major grain in Tanzania following maize. Rice production jumped from 890,000 tons per year in 2009 to 2.28 million tons (white rice equivalent) in 2018, making Tanzania the third largest rice producer in SSA following Nigeria and Madagascar. One of the reasons for the rapid increase in rice production in Tanzania is thought to be the increase in rice consumption due to changing consumer preferences and ease of preparation. The fact that "if you make rice, you can sell it" motivated farmers to produce more rice and expand their rice cultivation areas. Another reason for the expansion of production is that the use of agricultural machinery has allowed working at the right time of the year, increasing yield and reducing losses. As a result, Tanzania has already met its domestic demand and is aiming to contribute to self-sufficiency within the East African region.

Following the implementation of ASDP from 2006/2007 to 2013/2014, ASDP Phase 2 (ASDP II) has been developed and a 10-year development program starting 2017/2018 has been finalized. ASDP II aims to improve access to locally adapted agricultural services for increasing labor productivity, value addition, and farm income. Specifically, it aims to increase the proportion of cultivating households through mechanized services for tractors and power tillers from 17% to 40% over 5 years starting from 2017/2018.

NRDS formulated in 2009 set a goal to increase paddy production from 900,000 tons in 2008 to 1.96 million tons by 2018. This required an increase in production per unit area from 0.5 to 2.13 ton/ha at that time to 1.6 to 3.5 ton/ha. The results in 2018 showed a steady increase in the area under cultivation, yield, and production of paddy. In particular, paddy production more than tripled in 10 years, reaching 3.41 million tons in 2018, far exceeding the target.

In 2019, NRDS2 was formulated, outlining the strategy for 2019–2030. NRDS2 aims to maintain rice self-sufficiency and increase the competitiveness of domestic rice by i) doubling the area under rice cultivation from 1.1 million ha (2018) to 2.2 million ha (2030); ii) doubling the paddy yield from 2 ton/ha (2018) to 4 ton/ha (2030); iii) reducing post-harvest losses from 30% (2018) to 10% (2030); and iv) promoting public-private partnerships and private investment. To increase paddy yield, it is necessary to work at the right time, and for this purpose, mechanization, use of soil testing kits, access to and appropriate use of inputs, and access to finance must be promoted. To reduce post-harvest losses, the NRDS2 targets include promoting the connectivity among manufacturers, dealers, post-harvest processing service providers, and small-scale farmers for ensuring timely harvesting, proper drying, and quality improvement.

5.2. Overview of agricultural mechanization

Mechanization in Tanzania has been mainly focused for upland crop production, with particular use of tractors for land preparation (plowing, harrowing, and leveling), which is highly laborious. Tractors are used not only for land preparation but also for multiple other purposes using various work equipment attached to the front and rear of the machine. Along with tractors, the use of machines for processing harvested products in sugar and maize flourmills has also advanced.

This survey found that not only tractors were used for rice cultivation, but also power tillers were used in small paddy fields. In small paddy fields in irrigated and rainfed lowland areas, combine harvesters with a harvesting width of approximately 2 m have been widely used for highly efficient and timely harvesting before the establishment of a harvesting system with a reaper and thresher.

(1) Land preparation work

Power tillers and tractors have been used in many parts of Tanzania for the past 10 years to expand the field area and perform work at the right time. However, in many rice-growing areas, planned work is not being performed. This is because the number of machines is insufficient, and farmers often cannot get service providers at the right time. In most rainfed areas, as the work needs to be done after rainfall, machines are used after the rain. In contrast, it is easier to plan work in irrigated areas, and service providers can prepare for the work in advance. This is because water use plans are usually prepared in irrigated areas.

CASE 70hp

FIELDKING

Tractor and rotary seen in the Lower Moshi Irrigation Scheme
Source: The survey team

(2) Rice transplanting work

In some areas, wet direct seeding is practiced; however, because of its rarity, it was not observed during this survey. In the rainfed rice fields of Morogoro District, the tractor is used to harrow with a disc harrow, spread the seeds (manual broadcasting), and then cover the soil again with a disc harrow. Even in such upland rice areas, harvesting is performed with a combine harvester when the timing and amount of rainfall are favorable. However, this is limited to areas where only one crop is harvested per year and the area of rice cultivation is large.

(3) Weeding work

Since weeding is mainly done manually, farmers uproot taller weeds, and there is little effect of the fertilizer used on rice. KATC and other extension workers in various areas instruct farmers on weeding approximately 2 to 3 weeks after planting rice, emphasizing the importance of weeding. KATC and MATI recommend the use of hand-push weeders (push weeder: a weeding tool that was also used in Japan) and manual rotary weeders to agitate waterlogged soil. Since hand-push weeders can be made with simple materials and carpentry tools, some farmers make and use their own weeders.

(4) Harvesting work (such as reaping, threshing, and winnowing)

Ordinary combine harvesters with a working width of approximately 2 m are often used in irrigated areas. There are no reports of workers engaged in manual harvesting, threshing, and winnowing works losing their jobs because of the use of combine harvesters. This is because there is a shortage of workers supporting agriculture. The combine harvesters used in Tanzania were made by Japanese, Chinese, and Indian manufacturers. In the 2 to 3 years since the preceding survey was conducted, the number of Japanese manufacturer brands began to increase.

(5) Rice milling processes

The Engelberg is rarely used as a rice milling machine in Tanzania. Although the one-pass system is used, small rice milling plants that consist of a destoner, a paddy separator that separates paddy grains from brown rice, and a combination of abrasion and friction whitening machines are already being used in many places.

(6) Transportation work

Haulage using trailers attached to power tillers and tractors is essential for transporting agricultural products and freight, including building materials throughout the year. In Tanzania, lightweight trucks of Japanese and Indian make are increasingly being used

5.3. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team:

5.3.1. Basic policy for the establishment of AFICAT (draft)

As of July 2021, when the field survey was conducted in Tanzania, activities in Tanzania were

restricted to Dar es Salaam, areas within an 8-hour drive from Dar es Salaam, and Arusha Region due to the effects of COVID-19. AFICAT activities are planned to initiate at KATC and the Lower Moshi Irrigation Scheme because JICA experts can visit these areas even under such circumstances; these areas are relatively close to the international airport; Japan has been supporting irrigation, rice cultivation, and field cropping in the Lower Moshi Irrigation Scheme since the 1970s; and technical cooperation projects based at KATC in the agricultural sector have been planned in the future. After the AFICAT project is launched, the scope of activities will be expanded to other MATIs and sites depending on the interest of Japanese companies and ease of restrictions on movement.

KATC main building

Machinery of Japanese brands (right: workshop and equipment storage)

Paddy fields in the Lower Moshi Irrigation Scheme

5.3.2. Candidate institutions/locations for collaboration with AFICAT (draft)

The Agricultural Mechanization and Irrigation Division and the Agricultural Training and Extension Services and Research Division of the Ministry of Agriculture will be the collaborating organizations and activities will start at KATC and the surrounding Lower Moshi Irrigation Scheme, where resources such as buildings, agricultural machinery, personnel, and fields are available to some extent. AFICAT will also collaborate with CAMARTEC, which is responsible for the inspection and certification of agricultural machinery, as required. CMARTEC is under the Ministry of Industry, Trade and Investment. Since the ministries are different, depending on the nature of the collaboration, a letter requesting collaboration must be submitted by the Ministry of Agriculture at the time AFICAT activities are initiated.

5.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

- This and past surveys and projects in Tanzania have confirmed that the buyers of agricultural machinery do not necessarily select models based on price alone. Even though the Japanese products are more expensive than those made in other countries, they realized that they are superior in terms of performance, durability, and part supply. In order for the value of the product to be commensurate with the price, the correct use of the product must be demonstrated by instructing its proper use for a certain period and monitoring the operation status. AFICAT is expected to compile such successful cases to provide information, demonstrations, and publicity in Tanzania.

- The next issue to be addressed is effortless and prompt supply of parts, including after-sales services. For users, the lack of availability of parts is a fatal flaw to promote agricultural mechanization. AFICAT will monitor the use of Japanese products to the extent possible, liaise with Japanese companies and local agents, and provide necessary advice to ensure prompt supply of parts and appropriate after-sales services.
- Although the use of agricultural machinery, particularly in irrigated areas, is increasing, the extent remains small, and there is much room for mechanization in the future. Combine harvesters made by Japanese manufacturers (standard type with a cutting width of around 2 meters) are becoming popular, and combine harvesters are being used even in small plots of 0.1 ha.
- Some farmers (in the Mombo Irrigation Scheme) have expressed interest in rice planting machines; however, AFICAT must carefully examine whether these machines can be used under Tanzanian conditions and whether the business of rice planting service provision can succeed.
- Government subsidies for agricultural machinery have not been identified, but the import of agricultural machinery is exempted from taxation. There are guarantee institutions for agriculture-related loans, and an environment is being created that will make it easier for financial institutions to provide loans to the agricultural sector. The number of institutions offering leases for agricultural machinery is also increasing, promoting agricultural mechanization in Tanzania.

6. Current Status of and Issues Related to Agricultural Mechanization in Cote d'Ivoire

6.1. Rice production and related policies

Rice is the major cereal crop in Cote d'Ivoire, and production increased rapidly from 450,000 tons in 2008 to 1.43 million tons in 2015 (in terms of white rice). Within SSA, the country ranks sixth in terms of rice production following Nigeria, Madagascar, Tanzania, Mali, and Guinea. Rice consumption is also increasing rapidly, and in terms of excess imports (rice imports minus exports), Cote d'Ivoire ranks fifth globally, with the import of 1.32 million tons, following the Philippines, Benin, Iran, and Saudi Arabia.

In 2020, Cote d'Ivoire produced 1,481,181 tons of rice (paddy), with almost all, except 2 out of the country's 104 departments, producing rice.

Similar to many SSA countries, Côte d'Ivoire relies on imports for much of its rice consumption. The National Rice Development Strategy (SNDR) was developed in 2008 and was revised in 2012 to strengthen activities for achieving the set goal. The revised SNDR set the goal of achieving rice self-sufficiency by increasing rice production from 604,000 tons in 2008 (929,600 tons on a paddy basis) to 2.11 million tons by 2018 (3.25 million tons on a paddy basis). However, rice production in 2018 was only 1.34 million tons (2.01 million tons on a paddy basis). The area under rice cultivation in rainfed areas is decreasing rather than increasing, although the cultivation area and yield in irrigated areas and floodplains have achieved the target.

In 2020, SNDR Phase 2 (SNDR2) was formulated, which outlines a strategy for the period up to 2030. Here, the goals are to achieve self-sufficiency in rice by 2025 and to make Cote d'Ivoire the largest rice exporter in Africa by 2030.

6.2. Overview of agricultural mechanization

In Cote d'Ivoire, agricultural machinery is mostly used in large estates or plantations that produce

commodity crops, such as sugarcane and oil palm. The machinery is mainly used for transporting harvested oil palm bunches in large plantations by towing trailers on tractors. In this case, the workload is less than that in land preparation, but the service life and operating hours are longer. This is one of the important criteria for the selection and evaluation of agricultural machinery.

(1) Issues for mechanization

The following are some of the issues emphasized by the government agencies to improve rice productivity and promote mechanization:

1) Productivity is low because very few machines are available, which delays the work, resulting in losses during harvest.
2) The plots are rather small for the introduction of machines, making efficient work difficult.
3) Some small plots still have stumps that were cut down during land preparation, making it impossible to introduce machinery.
4) Prices of agricultural machinery are high, while after-sales services from dealers are almost non-existent, and consumable parts may not be readily available.
5) There is lack of skills and experience among operators, leading to improper operation and irregular maintenance of the machines, which often results in premature breakdown.

John Deere 5075E (75hp) for upland crops

(2) Service providers

There are two types of service providers: services provided by wealthy farmers using their own machines and by PMEAs ("small and medium agricultural enterprises," referred to as "service providers" in this report, as in other countries). PMEAs include companies that provide only agricultural machinery services as well as those that are primarily engaged in agricultural management and have a legal body.

6.3. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team:

6.3.1. Basic policy for the establishment of AFICAT (draft)

In Cote d'Ivoire, AFICAT will be implemented in collaboration with PRORIL2. The following ways of collaboration between PRORIL2 and AFICAT are proposed:

- Activities of PRORIL2 and AFICAT should be complementary and should be effectively and efficiently coordinated. To make clear the responsibilities of both projects, the activities of PRORIL2 [Project Design Matrix (PDM)] and AFICAT should be clearly separated.
- Accordingly, AFICAT's activity plan will be implemented by assigning separate AFICAT experts and local staff (that is, AFICAT's activities will not be entrusted to PRORIL2 experts and CPs).
- Meanwhile, AFICAT's activities should be shown to external parties including the government of Cote d'Ivoire and Japanese companies as "all JICA's support for the promotion of mechanization" together with

PRORIL2.

- In terms of agricultural machinery-related activities, PRORIL2 will conduct verifications and demonstrations of agricultural machinery that is expected to be used immediately in the country, while AFICAT will support verifications and demonstrations of agricultural machinery that Japanese companies wish to promote in the country, taking into account the medium-to-long-term perspective.
- The office of PRORIL2 can be shared with the AFICAT team. Regarding the storage of agricultural machinery, the site where the PRORIL2 office is located and the seed warehouse of ADERIZ in Yamoussoukro are possible sites, which will continue to be examined by the AFICAT team.
- To implement AFICAT, its plan must once again be clarified to the local government agencies, such as MINADER (mainly DMEME), ANADER, and ADERIZ, and a consensus must be reached. ANADER will be the point of contact for formal documents with AFICAT on cooperation with CFMAG.

6.3.2. Candidate institutions/locations for collaboration with AFICAT (draft)

As mentioned above, AFICAT will operate in cooperation with PRORIL2, and it is necessary to promptly share information on the specifications and operational status of Japanese agricultural machinery to be introduced by PRORIL2 and ADERIZ. Therefore, the project office of PRORIL2 located in Yamoussoukro will be the base of AFICAT activities. The reasons are that there are office space and storage of agricultural machine and equipment (storage needs further consideration, though), and main production areas of rice are located near Yamoussoukro, where Japanese experts can visit. As the PRORIL2 progresses and Japanese companies become interested in expanding their activities, AFICAT activities will be expanded to fields near Buakye, CFMAG in Grand Lahou, etc., in addition to Yamoussoukro.

CFMAG in Grand Lahou

6.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

Agricultural machinery

- Agricultural mechanization in the rice sector is not very advanced, and there is large room for mechanization. Although Japanese agricultural machinery is well known to some government officials due to the introduction of Yanmar and Kubota products in the past through grant aid, it is not well known to the general public.
- In PRORIL2, agricultural machinery, including Japanese equipment, will be introduced and their local suitability and profitability will be examined. When these are confirmed, the results will be publicized through AFICAT, which will help raise the profile of Japanese products.
- As a countermeasure against COVID-19, ADERIZ received a budget for the purchase of agricultural machinery and introduced some agricultural machines of Japanese manufacturers, which is considered

to be a good opportunity to improve brand recognition of Japanese agricultural machinery. Since ADERIZ will be in charge of monitoring the results of this measure, AFICAT will also pay strong attention to it. AFICAT will strengthen public relations when the superiority and profitability of Japanese products are demonstrated through PRORIL2 and ADERIZ.

7. AFICAT Establishment Policy (draft)

Based on the results of interviews with relevant parties, including Japanese companies, field surveys, and discussions with JICA, the following overall concept and short-to-medium-term and long-term activities are proposed for the establishment of AFICAT.

7.1. Overall concept for the establishment of AFICAT (draft)

7.1.1. AFICAT's activities will be planned in the short, mid-, and long term

(1) Objectives of the short-, mid-, and long-term activities

AFICAT was announced at TICAD7 as a new initiative to be undertaken through public–private partnership. To achieve this, the steps for confirmation of the local suitability and usefulness of the products, technologies, and services provided by Japanese companies, followed by their dissemination and acceptance in SSA countries, will be taken. To implement this project, the AFICAT plan will be formulated, monitored, and reviewed at each step while carefully assessing the intentions of Japanese companies and relevant organizations in SSA.

Accordingly, the AFICAT plan will be designed by dividing the activities into short-term, mid-term, and long-term plans. In the short term, AFICAT will be operated on a trial basis for approximately 2 years starting in the first half of 2022, and the knowledge and experiences gained from the trial operation will be accumulated for mid-term operation. In the mid-term, while confirming the suitability and usefulness of as many products and technologies of Japanese companies as possible, products and technologies that have been proven successful will be gradually disseminated. Specifically, the five target countries of this survey will be selected as key countries for AFICAT, and the number and range of the functions of AFICAT, locations of its activities, and number of products and technologies introduced will be gradually increased. In the long term, it is expected to develop a structure in which AFICAT can be operated in sustainable manner. The major milestones and status of AFICAT activities expected at that time are summarized in the table below.

Table Major milestones and status of AFICAT activities expected

Milestone	Status of AFICAT activities expected
August 2022 TICAD8 (planned)	▪ AFICAT is launched in the key countries in East and West Africa ▪ Some Japanese companies are participating in AFICAT
2025 TICAD9 (planned)	▪ AFICAT activities continue in the key countries in East and West Africa ▪ Expansion of AFICAT activities to other parts of the key countries and neighboring countries begins
2028 TICAD10 (planned)	▪ AFICAT activities continue in the key countries of East Africa and West Africa. AFICAT activities have spread to the neighboring countries. ▪ AFICAT activities are established in the key countries and are being implemented in a sustainable manner.

(2) Targets of the short-time plan

As momentum and consensus for the implementation of AFICAT have been formed at TICAD7, AFICAT is expected to receive materials and equipment from Japanese companies and start its activities by the beginning of FY2022 at the latest.

(3) Options of long-term management structure for AFICAT

At present, the following options are considered for the long-term management of AFICAT. Ideally, AFICAT should be managed by Japanese companies, local agencies, or government agencies without support from donors, such as JICA. Such point of view will also be examined through AFICAT activities in the short and mid-term.

1) An AFICAT promotion advisor is assigned for each country
2) AFICAT is implemented through technical cooperation projects
3) JICA bear the operational costs in cooperation with local organizations that support AFICAT's verifications

7.1.2. AFICAT will simultaneously operate in East and West Africa

For AFICAT to provide solutions for various challenges in agricultural mechanization, it is important to encourage as many Japanese companies as possible to participate in AFICAT. Furthermore, it is desirable to operate AFICAT in several countries in SSA, specifically in East and West Africa, which are geographically and culturally diverse. AFICAT will therefore start the operation at the five key countries[1].

7.1.3. AFICAT will serve seven functions

Based on the results of interviews with Japanese companies, the seven functions of AFICAT were revised as below.

[1] Kenya still remains as the key country because Japanese companies are highly interested, and the possibility to conduct of the survey and the commencement of AFICAT is examined.

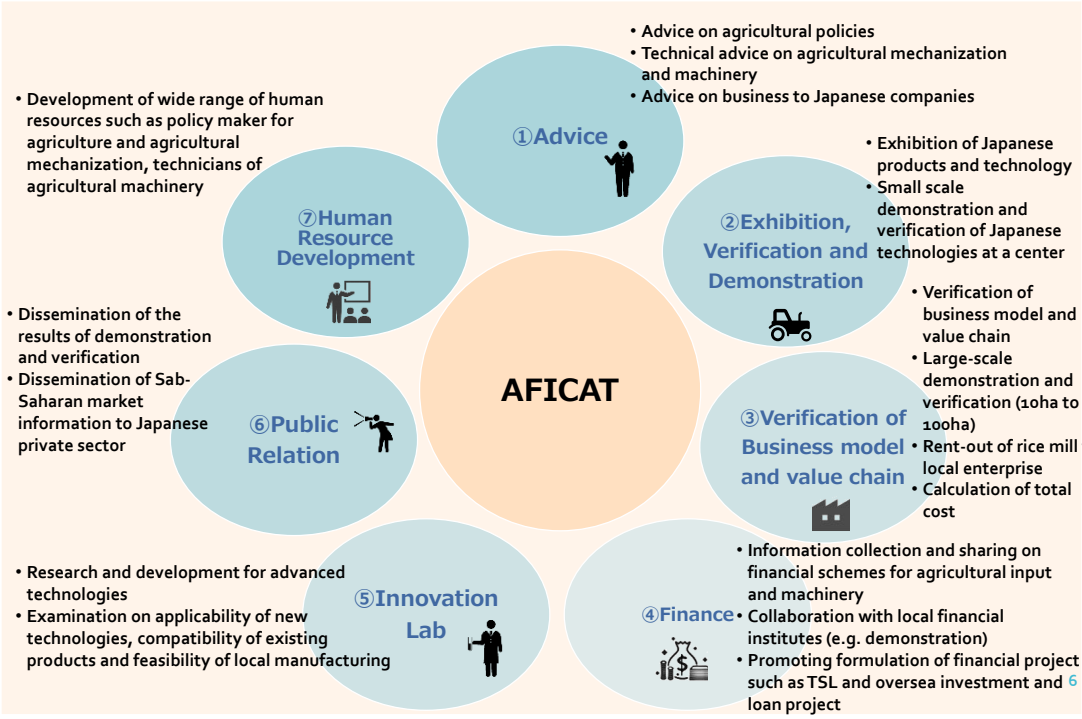

Figure Revised seven functions of AFICAT

7.1.4. Resources for AFICAT operations will be born between the public and private sectors

AFICAT is expected to operate in a sustainable and self-sustaining manner in the long term, requiring a high level of commitment from all parties involved in its operation. The table below summarizes the proposed resource burden for AFICAT operation. At AFICAT, it will be possible to conduct verifications and demonstrations of Japanese companies' products that have already been introduced in the country.

Table Resources for AFICAT operations to be provided by each stakeholder (draft)

		Government and private sector in SSA	Japanese government/JICA	Japanese companies
1	Land and building	◎	○ Rehabilitation of facilities, office and farmlands	-
2	Human resources	◎	△	○ Dispatchment of Japanese technicians or staff of local dealers
3	Agricultural machinery	○ Machinery to be used for rice production.	△	◎ Provision of machinery for exhibition, verification, and demonstration
4	Agricultural materials	○ Materials to be used for rice cultivation	△	◎ Provision of materials for exhibition, verification, and demonstration
5	Operation cost (fuel/facility maintenance)	◎	△	-

Note: ◎: mainly provided; ○: partially provided; △: provided for a certain period until AFICAT is fully operational.

7.1.5. Japanese companies will be supported to promote their products

AFICAT aims to promote agricultural mechanization in SSA by disseminating the products and technologies of Japanese companies. During AFICAT activities, such as exhibition, verification, and demonstration of its products, Japanese companies are expected to establish a local sales and maintenance structure, including the supply of spare parts. AFICAT will provide Japanese companies with relevant local information and potential distributors, and advice to help them establish such a structure within a short period.

The Japanese products are often characterized as "good quality but expensive." AFICAT, as a neutral third-party organization, will work with local government officials to analyze the results of verifications and demonstrations of Japanese products for confirming their superiority in terms of total cost, taking into consideration factors such as service life, maintenance costs, and fuel efficiency. AFICAT will also support the promotion of Japanese companies' products by publicizing verified products and technologies.

7.1.6. AFICAT will contribute to development issues, strengthen the capacity of local government officials, and promote sustainable development in recipient countries

AFICAT activities, such as demonstrations and verifications of agricultural machines, verification of business models, etc., with local stakeholders will lead to their capacity building in agricultural mechanization of the country. It is expected that AFICAT will eventually be managed mainly by local government agencies and the local private sector in collaboration with Japanese companies. To respect the policies, strategies, and intentions of the local government, to assess the implementation capacity of the local government, and to establish an implementation structure for sustainable operation of AFICAT, it is essential to involve local stakeholders as much as possible from the early stages of AFICAT operation.

In addition, if local stakeholders can proactively promote agricultural mechanization with the private sector, including Japanese and local companies, this can improve productivity and reduce post-harvest losses in the mid- to long-term; in this way, AFICAT can contribute to solve development issues in the agricultural sector.

7.1.7. AFICAT will seek opportunities to collaborate with JICA projects, such as grant aid projects, and procurement of equipment and materials through technical cooperation projects

The Japanese government and JICA are implementing many grant aid projects and technical cooperation projects in SSA. It is expected that the products and technologies of Japanese companies that have been verified or developed by AFICAT will be widely utilized to broaden the impacts of these projects. To promote such cooperation, it is necessary to review the nature of grant aid projects and equipment procurement procedures where possible; for example, the bidders would be requested to submit after-sales services and future business development plans in the procurement process during grant aid and technical cooperation projects.

In many SSA countries, there are very few financing schemes for agricultural machinery. When the products of Japanese companies are popularized to a certain extent in the target countries, financial schemes, such as two-step loans for agricultural machinery and materials, including Japanese agricultural machinery, can be expected.

7.1.8. AFICAT will consider establishing AFICAT secretariat and AFICAT hub countries

(1) Establishment of AFICAT secretariat

It is necessary to establish a "secretariat" function for overseeing and coordinating all AFICAT activities across the countries. It is proposed to introduce secretariat under the JICA headquarters.

(2) Establishment of hub countries for AFICAT

The five key countries are also potential hub countries for the expansion of AFICAT activities in SSA. Considering the economic zones, several groups of priority countries and neighboring countries can be assumed in SSA. In Japan, in addition to JICA headquarters, JICA Tsukuba will be positioned as the base and the possibility of cooperation with AFICAT, particularly in terms of human resource development and exhibition and demonstration of Japanese products, is considered. Accordingly, a suitable structure including SSA and Japan will be examined, and the organizations in charge and their roles in expanding AFICAT activities will be reviewed.

(3) Establishment of a structure for information sharing among AFICAT key countries

Among the four countries surveyed, Tanzania has a relatively well-developed financial system in terms of loan schemes that can be availed to purchase agricultural machinery, guarantee systems that promote the use of loans for purchasing agricultural machinery, and leases that promote the use of agricultural machinery. In addition, many farmers in Tanzania are replacing the currently used Chinese combine harvesters with Japanese ones for paddy harvesting.

To promote similar replacement in countries other than Tanzania, it is desirable to create an opportunity to share such cases with other countries where AFICAT will be established. JICA Tsukuba is planning to start the subject-specific supplementary overseas training program (PAMA) in one of the SSA countries after the training is done in Japan. TANRICE3 will receive trainees from neighboring countries in Tanzania. At CARD meetings, a structure to share information among SSA countries, including AFICAT key countries, should also be established.

7.2. Short-term activity plan (draft)

7.2.1. Policies for implementing activities in the short term

The following is proposed as the basic policies for short-term activities:

(1) AFICAT will focus on agricultural machinery for rice at first

As the crops change, the local government organizations that work with AFICAT may also change. Since AFICAT is expected to contribute to CARD and rice is one of the crops where Japanese agricultural machinery is strong, AFICAT will start its activities focusing on machinery related to rice.

(2) AFICAT will start with limited locations and functions

Considering the limited time before TICAD8 and the lack of prospects for lifting restrictions on activities due to COVID-19, AFICAT will start on a small scale with a limited number of areas and partner organizations. Among the seven functions, AFICAT will focus on (1) advice; (2) exhibition, verification, and demonstrations; (3) verification of the business model and value chain, and (6) public relations. Thereafter, the number of activity areas and collaborating organizations will be gradually expanded in accordance with the interests of Japanese companies and local conditions.

7.2.2. Implementing structure

In the short-term, the AFICAT team should be formed so that the four countries, except Kenya, can be proceeded with almost simultaneously. It is expected that verification of Japanese products is started by TICAD8; therefore, the short-term activities will include coordination with CP and other local government organizations, assist in preparation of receiving the products from Japan, custom clearance and transportation, etc. At the early stages of AFICAT, it will also be necessary to explain the project plan to the relevant local organizations, obtain their agreement for cooperation, and conclude the agreement documents when necessary. In addition to Japanese experts, it is important to assign local government officials or local consultants.

7.2.3. Activities

The main activities in the short-term will be as follows:

1) Collecting the following basic information:
- Trends in agricultural mechanization and rice promotion
- Rice production, major production areas, yield, and cropping pattern
- Outline of the rice value chain
- Major stakeholders
- Government agencies locally responsible for product development and improvement
- Information on crops other than rice (priority: low)
- Candidate companies for distributors
- Other support for Japanese companies

2) Encourage Japanese companies to participate in AFICAT
3) Support for the preparation of activity plans for Japanese companies
4) Support for necessary procedures such as the inspection and registration of Japanese products
5) Exhibition, verification, and demonstration
6) Public relations
7) Coordination with the relevant organizations and schemes in Japan such as JICA Tsukuba Center, JICA public–private partnership program, JETRO, MAFF, JIRCAS, NARO, and CARD Secretariat

Chapter 1. Overview of the Survey

1.1. Background of the survey

The African Business Council's Agriculture Working Group introduced the Agriculture Innovation Platform in Africa (AIPA) during the Plenary Session 3 Public-Private Business Dialogue of the Seventh Tokyo International Conference on African Development (TICAD7) held in August 2019. The platform aims to develop the agricultural sector in Sub-Saharan Africa (SSA) by focusing on three key issues: empowering farmers to build and strengthen food value chains, increasing productivity, and intervening in the value-adding of crops. Two of the priority actions to achieve these goals include (1) the development of an agricultural digital base, and (2) the introduction of advanced agricultural technologies. These steps are expected to encourage Japanese companies to participate, invest, and provide their value in SSA. Thus, the Japanese Government set forth "support this through the TICAD initiative and policy dialogue."

For realizing action (2) mentioned above, a survey was conducted to establish the "Africa Field Innovation Centre for Agricultural Technology (AFICAT)"[2] and materialize it. In AFICAT, "the utilization of agricultural machinery" was set as the major component of advanced agricultural technology.

In addition to the above-mentioned agricultural working group, Japan International Cooperation Agency (JICA) has established networks (platforms) for domestic stakeholders to promote activities aimed at solving problems in developing countries and Japan for achieving the sustainable development goals (SDGs). As one of the networks, the JICA Platform for Food and Agriculture (JiPFA) was launched in FY2019 with the aim of jointly implementing various activities among the private sector, government, and academia. JiPFA has 13 subcommittees, each with its own theme. Of these, the Agricultural Machinery Subcommittee discusses measures to introduce agricultural technologies in SSA.

To complement discussions of the JiPFA Agricultural Machinery Subcommittee, JICA conducted the "Data Collection Survey on Agricultural Mechanization in Sub-Saharan Africa in Collaboration with Japanese Private Sector" (hereinafter referred to as "the preceding survey") from February to September 2019. The preceding survey was aimed at proposing JICA activities and official development assistance (ODA) schemes that can contribute to the improvement of productivity and value addition as well as support Japanese companies to expand their business in SSA after confirming the status of the utilization of agricultural machinery and advantages of Japanese manufacturers in SSA, where agricultural mechanization has not progressed as yet. The preceding survey revealed that for Japanese companies to introduce advanced agricultural technologies, particularly agricultural machinery, exhibiting and demonstrating agricultural machinery at model fields would be beneficial. To realize this, issues and required actions that should be addressed by the public and private sectors were summarized in the final report as recommendations.

The results were discussed at the JiPFA, the "Agriculture Working Group of the African Business Council" organized by the Japanese Government, and the "Global Food Value Chain Public-Private Council" organized by the Ministry of Agriculture, Forestry and Fisheries. Subsequently, as mentioned above, this plan was announced to the African leaders and other participating representatives at the business dialogue of TICAD7 as one of Japan's cooperative development efforts in the field of agriculture within SSA.

[2] The word "innovation," which is part of the name of the center, does not necessarily mean that everything that will be introduced at the center will be technologically "innovative." The name is derived from "new" technologies that meet the needs of Africa and are better than the ones currently available.

1.2. Purpose of the survey

The purpose of this survey is to compile information on the establishment of AFICAT, a center for exhibition, demonstration, human resource development, and innovation to promote advanced technologies and agricultural mechanization in SSA and contribute to the improvement of agricultural productivity and quality of agricultural products. The center will also serve as a foothold for Japanese manufacturers to promote their business in SSA, assuming that the center will be promoted by the public and private sectors of Japan and Africa. The activities at AFICAT will not be limited to the products of Japanese companies and will also include African companies entering the market.

At the start of this survey, four countries, namely Kenya and Tanzania in East Africa and Cote d'Ivoire and Nigeria in West Africa, were selected as the priority countries for the establishment of AFICAT; however, Ghana was added based on discussions with Japanese companies after the survey. As a result of coordination between the Kenyan government and JICA, Kenya was excluded from the survey. Therefore, field surveys were conducted in four countries, namely Tanzania, Cote d'Ivoire, Nigeria, and Ghana, and information was compiled.

1.3. Survey process and team

1.3.1. Survey process

The survey was initiated in April 2020 and was conducted following the process shown below.

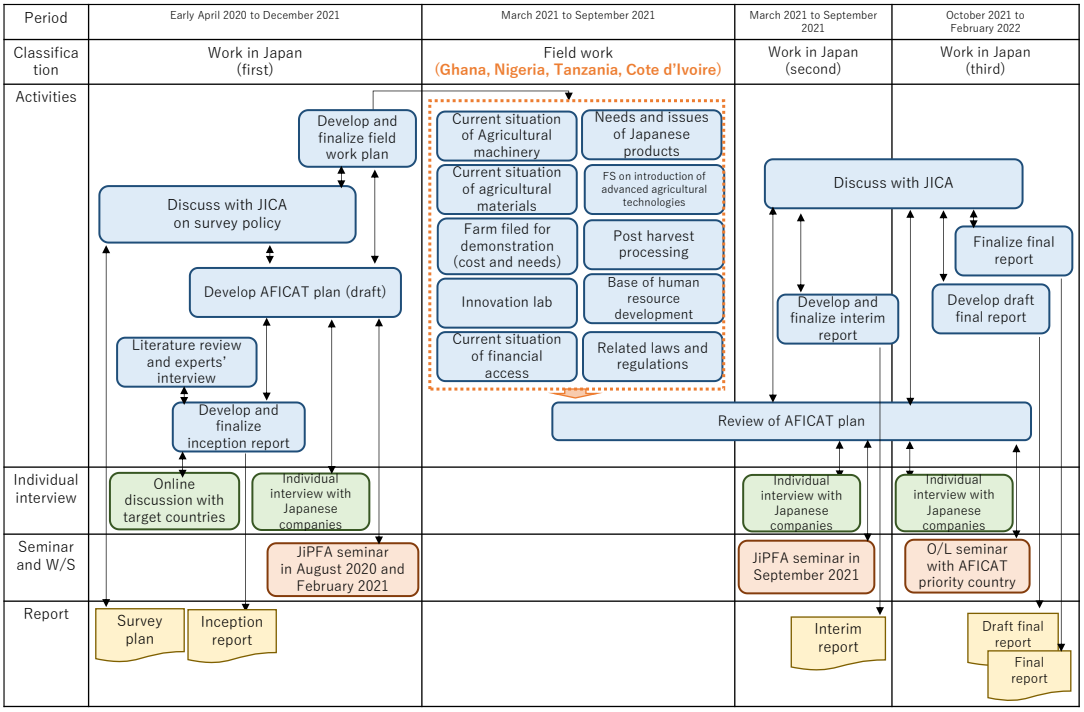

Figure 1-1 Flowchart of the survey process

1.3.2. Survey team

Table 1-1 lists the members of the survey team in charge of the process, their areas of responsibility, and the duration of the field survey.

Table 1-1 Composition of the survey team

Name	Responsibilities	Field survey period
Hiroshi Okabe	Team leader/Needs Survey of Japanese Companies 1/Policy and regulation	Ghana: March 25 to April 5, 2021 Tanzania: July 9 to July 18, 2021 Cote d'Ivoire: September 11 to September 26, 2021
Fumiko Ikegaya	Deputy team leader/market research	Ghana: March 18 to April 5, 2021 Nigeria: May 14 to June 7, 2021 Tanzania: July 3 to July 18, 2021 Cote d'Ivoire: September 11 to September 26, 2021
Koji Yamaguchi	Agricultural machinery/Postharvest processing facilities	Ghana: March 11 to April 5, 2021 Nigeria: May 14 to June 7, 2021 Tanzania: July 3 to July 18, 2021 Cote d'Ivoire: September 11 to September 26, 2021
Naoki Takanashi	Rice farming /Agricultural materials	Ghana: March 11 to April 5, 2021 Nigeria: May 14 to June 7, 2021 Tanzania: July 3 to July 18, 2021 Cote d'Ivoire: September 11 to September 26, 2021
Emi Wakita	Finance 1/Needs Survey of Japanese Companies 2	Ghana: March 18 to April 5, 2021 Nigeria: May 14 to June 7, 2021 Cote d'Ivoire: September 11 to September 26, 2021
Mie Kobayashi	Finance 2/Needs Survey of Japanese Companies 3	Tanzania: July 3 to July 18, 2021

1.4. Policies related to the AFICAT concept

Japan's policies related to the AFICAT concept and their relevance are summarized below.

1.4.1. Support measures for TICAD

TICAD is an international conference on development in Africa, led by the Japanese Government since 1993, in collaboration with the United Nations, United Nations Development Programme (UNDP), World Bank, and African Union Commission (AUC). TICAD7 was held in Yokohama, Japan, from August 28 to 30, 2019, and involved over 10,000 participants, including representatives from 53 African countries[3], 52 development partner countries, 108 international and regional organizations, and civil society organizations, such as the private sector and non-governmental organizations (NGOs). From Japan, Prime Minister Shinzo Abe co-chaired the conference with Egyptian President El-Sisi [Chairman of the African Union (AU) at the time] to promote business dialogue between the public and private sectors[4]. TICAD7 celebrated the achievements thus far in the three pillars of TICAD7: (1) economy (promoting economic structural transformation and improving the business environment through innovation and private sector involvement), (2) society (developing sustainable and resilient societies), and (3) peace and stability (strengthening peace and stability). Furthermore, persistent challenges were highlighted and the need for promoting continuous collaboration and action for further development emphasized. The promotion of innovation in the agricultural sector by the public and private sectors proposed in the public–private business dialogue has been set as an initiative for the economic sector. In addition, Japan's initiatives in the agricultural sector include doubling rice production (from 28 to 56 million tons) through Coalition for African Rice Development (CARD), supporting the establishment of a global food value chain, developing and deploying agricultural technologies, and dispatching agricultural experts[5]. TICAD8 is scheduled to be held in Tunisia in 2022, and the Japanese

[3] Including 42 heads of state
[4] Ministry of Foreign Affairs website (https://www.mofa.go.jp/mofaj/area/ticad/index.html)
[5] Ministry of Foreign Affairs website (https://www.mofa.go.jp/mofaj/area/ticad/ticad7/pdf/ticad7_torikumi_ja.pdf)

Government has expressed that it will continue to strongly support the development led by Africa itself toward TICAD8 based on the outcomes of TICAD7[6].

1.4.2. Coalition for African Rice Development

JICA in collaboration with the international NGO the "Alliance for a Green Revolution in Africa" (AGRA) launched the international initiative CARD at TICAD4 in 2008 with the goal of doubling rice production in SSA (from 14 to 28 million tons) in 10 years. JICA, as one of the governing bodies of CARD, has supported the formulation of the National Rice Development Strategy (NRDS) for 23 African countries participating in CARD as well as supported the increase of rice production in line with the strategies of each country in collaboration with 10 international organizations and research institutes, including AGRA.

At the TICAD Ministerial Meeting held in October 2018, the success of CARD in doubling rice production in only 10 years (by 2018) was declared, and a new ambitious target of doubling rice production further by 2030 was set as CARD2. To achieve this goal, five of the CARD member countries[7] have developed strategies for the mechanization of rice production, and donor support, including budgets for the implementation of these strategies, is imperative. The RICE (resilience, industrialization, competitiveness, and empowerment) approach has been set forth in CARD2. As such, industrialization involves promoting Japanese agricultural machinery manufacturers to enter the market; competitiveness involves promoting Japanese post-harvest processing manufacturers to enter the market; empowerment involves support for improving access to finance. From this viewpoint, support for promoting the entry of Japanese agricultural machinery manufacturers is consistent with the RICE approach of CARD.

1.4.3. Sustainable development goals

SDGs are the international goals for the period from 2016 to 2030 that were included in the "2030 Agenda for Sustainable Development," adopted at the United Nations Summit in September 2015 as the successor to the millennium development goals (MDGs) established in 2001. The agenda comprises 17 goals and 169 targets to establish a sustainable world and aims to "leave no one behind" in development[8].

The second SDG is to "end hunger, achieve improved food security and nutrition, and promote sustainable agriculture." Target 2.3 is to "double the agricultural productivity and incomes of small-scale food producers," and target 2.a is to "increase investment in rural infrastructure, agricultural research and extension services, technology development, and plant and livestock gene banks through international cooperation for enhancing agricultural production capacity." In addition, SDG target 12 is to "ensure sustainable consumption and production patterns," and target 12.3 is to "reduce food losses in production and supply chains, including post-harvest losses." To achieve these targets, ODA support for Japanese agricultural machinery manufacturers to enter SSA is expected.

1.4.4. Infrastructure system export

The global demand for infrastructure, particularly in developing countries, is enormous, and the

[6] Ministry of Foreign Affairs website (https://www.mofa.go.jp/mofaj/press/release/press4_008594.html)
[7] Cameroon, Guinea, Madagascar, Burkina Faso, and Cote d'Ivoire
[8] Ministry of Foreign Affairs website (https://www.mofa.go.jp/mofaj/gaiko/oda/sdgs/about/index.html)

market is expected to expand in the future due to rapid urbanization and economic growth. To achieve economic growth through the export of infrastructure systems, the Japanese government formulated the "Strategy for Exporting Infrastructure Systems" in 2013, which included the government's key performance indicator (KPI) of "Japanese companies winning 30 trillion yen in overseas infrastructure projects by 2020." In 2018, this value reached 25 trillion yen, approaching the target. Since 2020 is the target year of the this strategy and the environment surrounding the development of infrastructure systems overseas is changing significantly, the Japanese government formulated the "Strategy for Overseas Development of Infrastructure Systems 2025" in December 2020[9].

In the agricultural sector, the following specific measures are being taken: strengthening the supply chain to cope with the impact of the COVID-19 pandemic; promoting the use of digital technology and data to cope with digital transformation; encouraging smart agriculture and building the relevant infrastructure; and forming a data platform for cooperation and collaboration among private companies. In addition, the project has set up a food value chain to solve local social issues as a concrete measure.

The African region is considered to have high potential as an infrastructure market, because it has achieved remarkable economic growth in recent years, backed by abundant natural resources and an increasing population. Regarding the agricultural sector in the African region, the policy is to support the expansion of agricultural production, reduction of production costs, and establishment of a food value chain through the introduction of quality seedlings and agricultural machinery.

[9] Keikyo Infrastructure Strategy Council (2020) Strategy for Overseas Development of Infrastructure Systems 2025

Chapter 2. Japanese Companies Related to Agricultural Machinery and Materials

2.1. Current situation and challenges of business in SSA for Japanese Companies related to agricultural machinery and materials

The domestic agricultural machinery market in Japan is approximately 380 billion yen, of which products from Japanese agricultural machinery manufacturers account for nearly 79% (around 300 billion yen)[10]. A total of 249 agricultural machinery manufacturing companies were listed in the "Major Agricultural Machinery Manufacturers 2018[11]." However, according to the Ministry of Agriculture, Forestry and Fisheries (MAFF), four major companies account for 80% of the total shipment value: Kubota Corporation (Kubota), Yanmar Holdings Co. Ltd. (Yanmar), Iseki & Co. Ltd. (Iseki), and Mitsubishi Mahindra Agricultural Machinery Co. Ltd. (Mitsubishi). In this survey, five companies, including these four companies and Satake Corporation (Satake), a major manufacturer of paddy processing machinery, were considered the "major agricultural machinery manufacturers."

In the preceding survey, with the cooperation of the Japan Agricultural Machinery Manufacturers Association (JAMMA), questionnaires were distributed to 143 companies, including 66 JAMMA member companies and 77 rice-related machinery manufacturers (companies other than JAMMA members) listed in the "Major Agricultural Machinery Manufacturers 2018." Questionnaires were collected from 36 companies and 76 companies responded via telephone. Table 2-1 summarizes the results for these 112 companies. Among them, only 32% companies have sold rice-related machinery overseas and only 15% companies have manufacturing bases overseas. Moreover, only 10% companies intend to enter the SSA market, and over 60% companies are targeting only the domestic market. In some cases, however, products sold in the domestic market are indirectly sold overseas, such as through other agricultural machinery manufacturers.

Table 2-1 Overseas sales and manufacturing and intention to enter SSA (112 companies)

			Yes	No	N.A.	Total
Manufacture of rice-related machinery overseas		(Number)	77	30	5	112
		(%)	69	27	4	100
Overseas sales	Overall	(Number)	50	56	6	112
		(%)	45	50	5	100
	Rice-related machinery	(Number)	36	70	6	112
		(%)	32	63	5	100
Overseas manufacturing bases	Overall	(Number)	22	90	0	112
		(%)	20	80	0	100
	Rice-related machinery	(Number)	17	94	1	112
		(%)	15	84	1	100
Intention to enter SSA		(Number)	11	101	-	112
		(%)	10	90	0	100

Source: Preceding survey

Of the 36 companies from which the questionnaires were collected, only 9 (25%) reported having sold their products in SSA. Regarding barriers faced or expected by these companies in expanding their sales

[10] MAFF (2016) The Current Situation of Agricultural Machinery in Japan
[11] Published by Shin-Norinsha Co., Ltd.

channels to SSA, the most common answer was “low priority in terms of business strategy” (18 companies, 50%), followed by “no or unsuitable distributors or dealers” (16 companies, 44%), “poor security,” “political instability,” “inability to establish after-sales service and maintenance systems,” and “low prices of competitors’ products in SSA” (13 companies each, 36%).

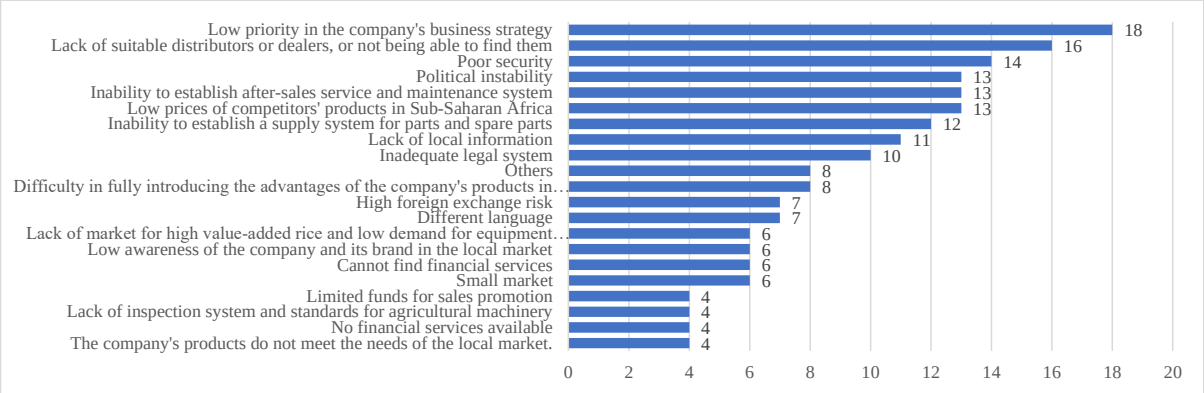

Figure 2-1 Challenges in expanding sales channels to SSA

Source: Preceding survey

2.2. Results of the survey of Japanese companies related to agricultural machinery and materials

From August to November 2020, individual interviews were conducted with 28 companies: 4 major agricultural machinery manufacturers, 14 agricultural machinery manufacturers related to rice and other agricultural products, 4 other companies including material manufacturers, and 6 general trading companies.

2.2.1. Intention to participate in AFICAT and requests regarding countries and regions where AFICAT will be established

The interviewed companies expressed an overall positive interest in the SSA market and high expectations of the establishment of AFICAT. The results of survey in which the companies were asked whether they were interested in participating in AFICAT and points that should be taken into account when considering a proposal to establish AFICAT are summarized below for major agricultural machinery manufacturers, other agricultural machinery manufacturers, material manufacturers, and general trading companies.

(1) Major agricultural machinery manufacturers

They expressed high interest in AFICAT, hoping that it would be operational at the earliest both in East and West Africa, and confirmed their interest in Madagascar, which is associated with high rice production. Meanwhile, they expressed concern regarding the lack of security in Nigeria.

(2) Other agricultural machinery manufacturers

Of the 14 agricultural machinery manufacturers other than major ones interviewed, only 5 expressed their intention to participate in AFICAT.

Of the 14, only 3 companies have local agents in SSA, and the remaining 11 have neither agents nor sales experience in SSA. This is because except for the major agricultural machinery manufacturers, the number of employees in charge of overseas sales is extremely limited, and many companies find it difficult to devote resources to gathering and analyzing information on SSA. For such agricultural machinery manufacturers, SSA is physically farther than Southeast Asia, Europe, and the United States, and they do not have a good grasp of local information. However, of the nine companies that did not express their intention to participate in AFICAT, only two explicitly denied entering SSA, while the remaining seven answered that they would consider it depending on the local demand and markets.

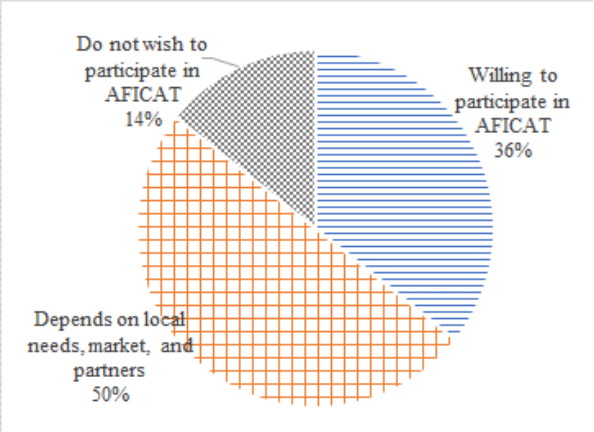

Figure 2-2 Other agricultural machinery manufacturers' intention to participate in AFICAT

Therefore, a forum should be established to actively share local information such that more companies can consider entering the SSA market through AFICAT. In particular, cooperation among three to five companies that are interested in entering the SSA market is recommended, and an "AFICAT utilization plan" and a business development plan should be devised in the country, together with the survey team, to make their participation in AFICAT as concrete as possible. The contents of the "AFICAT utilization plan" are listed in Table 2-2.

Table 2-2 AFICAT utilization plan

<table>
<tr><th></th><th>Contents</th></tr>
<tr><td>Outline of the agriculture sector in the country</td><td>▪ Government policy (e.g., self-sufficiency, crop diversification, and export promotion, among others)
▪ Major crops</td></tr>
<tr><td>Crops for which Japanese companies' products can be used and its overview</td><td>▪ Rice production region
▪ Total area: xx ha
▪ Total production: xx ton
▪ Major farming system (crop calendar)
<table>
<tr><th>Month</th><th>Activity</th><th>Utilization of machinery</th></tr>
<tr><td>Xxx</td><td>Land preparation and fertilization</td><td></td></tr>
<tr><td>Xxx</td><td>Planting</td><td></td></tr>
<tr><td>Xxx</td><td>Weeding</td><td></td></tr>
<tr><td>Xxx</td><td>Additional fertilization</td><td></td></tr>
<tr><td>Xxx</td><td>Harvest</td><td></td></tr>
</table>
▪ Major machinery (e.g., specifications of tractors used in the area)
▪ Other information that the company needs</td></tr>
<tr><td>Activity plan by function and location</td><td>▪ X agricultural experimental field will be used as an AFICAT demonstration plot, and rice will be grown using the product in zz during XXX (demonstration).
▪ The results of the demonstration will be shared with government agricultural extension agents and farmers at the Field Day scheduled on Month Day, Year.</td></tr>
<tr><td>Activity period</td><td>▪ Month Day, Year, to Month Day, Year</td></tr>
<tr><td>Expenses paid</td><td>▪ Company:
▪ Local government:</td></tr>
</table>

	Contents
	▪ JICA: ▪ Others:
Business plan after entering AFICAT	▪ By Month Day, Year, the company decides whether to enter to the SSA market based on the result of AFICAT activities. ▪ By Month Day, Year, the company identifies a local agent and registers their products to the local authority. ▪ By Month Day, Year, the company starts selling their products in the country.

(3) Agricultural material manufacturers

Of the four companies, two agricultural material manufacturers interviewed expressed interest in joining AFICAT. They also reported willingness to provide their products free of charge.

(4) General trading companies

General trading companies have operation bases in SSA and also invest in agriculture-related companies in various forms. Of the six general trading companies, four expressed interest in participating in AFICAT.

General trading companies are involved in a wide range of businesses, including investment, and have the potential to collaborate with AFICAT in ways differently from agricultural machinery manufacturers are. Specifically, these companies may be involved in various ways, such as establishing a human resource development center; developing sales channels under the value chain; and investing in local agricultural corporations, agricultural machinery service companies, and start-ups. Exchange of information with such companies is recommended to identify ways to promote their collaboration with AFICAT.

2.2.2. Agricultural machinery and materials granted or lent

Although the intentions regarding granting or lending machinery and materials and dispatching personnel vary across companies, more companies are willing to provide products for small than for large agricultural machinery and agricultural materials than small agricultural machinery. Of the four major agricultural machinery manufacturers, only two clearly stated willingness to provide or lend agricultural machinery free of charge. Meanwhile, over half of the other agricultural machinery manufacturers (8 out of 14) said that they may provide or lend agricultural machinery free of charge. Two agricultural material manufacturers reported that they can provide their products free of charge.

In the case of tractors and other large agricultural machinery, even if free lending is possible, the companies pointed out difficulties in loaning this machinery for a long period due to accounting and taxation issues. As described below, AFICAT will verify the total cost of using agricultural machinery and that in the value chain as a whole, which would require a wide variety of machinery and materials, and it would be difficult for the Japanese companies to provide or lend all of them free of charge. Therefore, a certain number of machinery and materials should be secured in cooperation with ODA projects, such as grant aid and technical cooperation projects[12].

[12] In the J-Methods Farming project implemented by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in India since FY2019, although Japanese companies, in principle, provide agricultural machinery and materials free of charge, the person in charge of the project reported to the survey team that it was very difficult to get tractors from companies free of charge. SSA is farther from Japan than India is, and many Japanese companies tend to set a lower priority to market development in SSA than in India.

2.2.3. Dispatchment of personnel

Seven of the 18 agricultural machinery manufacturers responded that they could dispatch personnel at their own expense, albeit on short-term trips. Some companies would like to travel, but strongly requested to receive a subsidy of nearly half the cost of the trip. The dispatch of human resources by Japanese companies must be supplemented through the use of remote technologies, such as online meetings from Japan, collaboration with JICA technical cooperation projects implemented in the area, and help from local staff.

2.2.4. Comments on AFICAT functions

Interviews with Japanese companies were conducted based on the assumption that seven functions described in Figure 2-3 would be provided. Major agricultural machinery manufacturers responded that almost all functions were important. However, many of the other agricultural machinery manufacturers did not in fact have information on SSA; thus, the importance of functions differed among the companies. Each company's opinions on each function are summarized in the figure below.

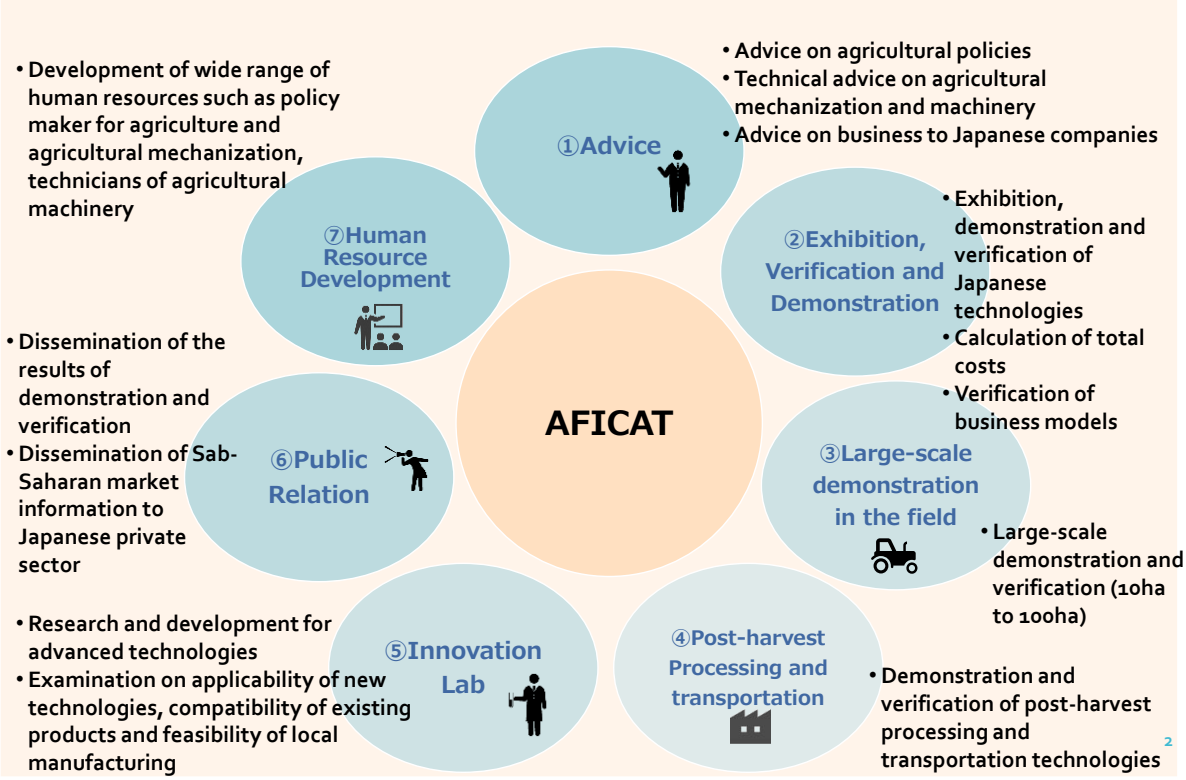

Figure 2-3 Seven functions of AFICAT

(1) Advice

As mentioned earlier, some of the major agricultural machinery manufacturers and many of the other agricultural machinery manufacturers do not have local information and require such information and advice. Essential information includes relevant laws and regulations required for business expansion in SSA, agricultural machinery sold and distributed, distributor information, local demand, local suitability of their products, local partners for local manufacturing, crop production volume, crop production system, overview

of tractors used locally (equipment manufacturers), subsidy for the purchase of agricultural machinery, and information on exhibitions, among others. Support for the import procedures for machinery and materials is also considered necessary.

(2) Exhibition, verification, and demonstration

Among the seven functions, the survey team received collective opinions on "(2) exhibition, verification, and demonstration," "(3) large-scale demonstration in the field," and "(4) post-harvest processing and transportation." Many agricultural machinery manufacturers place importance on verification and demonstration in market development. Many companies that are positively considering entering SSA through AFICAT have high expectations from functions related to verification and demonstration. They pointed out the importance of verifying not only the performance of agricultural machinery but also the total cost of using the machinery, possibility of using the machinery in the value chain, and importance of demonstrating business models, such as agricultural machinery rental services.

(3) Innovation lab

The expected functions of "(5) innovation lab" include activities, such as a place for research and development, evaluation of the feasibility of local manufacturing, and development of standards for agricultural machinery performance inspection and for agricultural products, including rice. Since local production may be essential for manufacturers to enter developing countries or local production of accessories (trailers or paddy wheels, among others) may be required in some cases, a facility to serve as the base for product development should be available.

In the long term, establishment of an inspection system for agricultural machinery will be essential to ensure quality, such that it can contribute to the dissemination of agricultural machinery. For instance, the Center for Agricultural Mechanization and Rural Technology (CAMARTEC) under the Tanzanian Ministry of Industry and Trade serves some such functions.

(4) Public relations

While some Japanese companies were willing to disseminate their knowledge and products in SSA, others appeared more cautious, reporting that some information on their own products could not be disclosed and that they would like to utilize information after considering the target and method of dissemination.

(5) Human resource development

All four major agricultural machinery manufacturers are aware of the need to train a wide range of human resources, including operators and repairers (mechanics). They also expressed their expectations for on-demand human resource development and training in Japan. The need to strengthen the capacity of distributors was also pointed out.

(6) Other required functions

1) Finance

Some companies felt that AFICAT should provide finance for selling their products in the local market and suggested adding financing as a function of AFICAT. Even though this would be difficult, some companies reported that they would prefer to gain information on finances that can be used locally.

2) Registration required

In some countries, fertilizers and agricultural chemicals for sale in the country must be registered per the local regulations. Accordingly, agrochemical manufacturers, in particular, reported that they would

prefer to gain information on which organizations conduct tests, what criteria are used to evaluate the products, and how can the products be registered and sold as imported materials.

2.2.5. Target crops

The survey team also interviewed Japanese companies that showed interest in joining AFICAT in the preceding survey and companies that were selected for JICA's private sector support program. As a result, a certain number of Japanese companies are now developing businesses that contribute to the improvement of agricultural productivity and value addition in developing countries, even for crops other than rice. Therefore, although rice is the priority crop for AFICAT, agricultural machinery and materials that target crops other than rice must also be considered.

2.2.6. Others

(1) Collaboration with other Japanese government organizations

In addition to the MAFF and JICA, there are other government organizations that support the overseas expansion of Japanese companies. Each local government of Japan has its own departments and organizations that support the overseas expansion of companies in a given area. Sharing information with JICA's private sector support program may also be effective in identifying promising companies and promoting participation in AFICAT.

AFICAT has similarities with J-Methods Farming, which MAFF has been implementing in India since FY2019, and it would be desirable to continue exchanging information with companies participating in J-Methods Farming, for instance, by requesting them to join AFICAT.

(2) Continuous information exchange with Japanese companies

It is important to continuously exchange information with Japanese companies to promote participation in AFICAT. As the survey team conducted more interviews with companies, including those in the preceding survey, they observed that the companies' interest in the SSA market has been increasing. Providing local information and continuing information exchange closely with these companies will increase their interest in SSA and AFICAT, encouraging them to participate in AFICAT.

2.3. Establishment plan of AFICAT (draft) based on consultation with Japanese companies related to agricultural machinery and materials

As a prelude to individual consultations and field surveys with the candidate countries for establishing AFICAT, a basic principle for the establishment of AFICAT was summarized as follows based on the results of the abovementioned interviews with Japanese companies.

(1) AFICAT will be simultaneously operational in East Africa and West Africa.

(2) AFICAT will start operational by TICAD8.

(3) Crops other than rice will also be targeted.

(4) The seven functions of AFICAT will be revised.

(5) A JICA technical cooperation project to promote AFICAT will be planned.

(1) AFICAT will be simultaneously operational in East Africa and West Africa

To encourage more companies to participate in AFICAT, it must be simultaneously operational in multiple SSA countries, particularly in East Africa and West Africa, even if the scale of activities is small. In West Africa, the possibility of establishing AFICAT in Ghana will be considered instead of limiting the activities to Nigeria because of security reasons and Japanese companies' interests.

(2) AFICAT will start operational by TICAD8

To gain and maintain momentum in the implementation of the AFICAT plan, it is important to start activities at the earliest. Assuming that TICAD8 will be held in August 2022, AFICAT functions should be partially operational by then. To achieve this, AFICAT must start receiving materials and equipment from Japanese companies by the fall of 2021 or by early 2022 at the latest. Accordingly, after determining which countries should be prioritized for AFICAT implementation, it is necessary to (1) incorporate AFICAT activities into JICA technical cooperation projects that are already underway or planned and (2) establish a new framework to examine AFICAT activities for their functionality. More specific principles of each are summarized below.

1) Incorporation of AFICAT activities into JICA technical cooperation projects

Some of the candidate countries for establishing AFICAT have rice-related JICA technical cooperation projects underway or planned and their implementing/planning activities are similar to those of AFICAT. Specifically, the JICA technical cooperation projects listed in Table 2-3 can potentially collaborate with AFICAT. Particularly in Cote d'Ivoire and Ghana, AFICAT functions can be included in JICA technical cooperation projects or AFICAT members can be assigned to make AFICAT operational.

Table 2-3 JICA technical cooperation projects that can coordinate with AFICAT in each country

JICA technical cooperation project		Collaboration (draft)
Kenya	Capacity Development Project for Enhancement of Rice Production in Irrigation Schemes	Synergistic effects can be achieved by overlapping the exhibition, verification, and demonstration sites with the activity areas of the project (Mwea and Western regions) and partner institutions.
Tanzania	Project for Strengthening Capacities of Stakeholders of Rice Industry Development	Synergistic effects are expected by overlapping the activity base with the same counterpart (CP) (Training Institute, Ministry of Agriculture). However, the launch of the new technical cooperation project may require some time.
Nigeria	Project on Promotion of Market-oriented Agricultural Extension System for Livelihood Improvement	As of December 2021, no rice-related technical cooperation projects have been implemented by JICA. Although the technical cooperation project listed on the left has started in 2020, a so-called Smallholder Horticulture Empowerment and Promotion (SHEP) project does not focus on the provision/loan of agricultural equipment, which must be considered separately.
Cote d'Ivoire	Local Rice Promotion Project Phase 2 (Projet de Promotion du Riz Local en République de Côte d'Ivoire 2: PRORIL2)	One of the outputs is "the establishment of a sustainable agricultural machinery service system." The addition of an AFICAT component and the assignment of AFICAT experts to PRORIL2 will allow AFICAT activities to begin relatively soon.
Ghana	New technical cooperation project	A project to support smallholder market-oriented agriculture and strengthen private sector linkages in the Kpong Irrigation Scheme (KIS) and the Sustainable Development of Rainfed Rice Farming Project Phase 2 has been implemented (ex-post evaluation completed); as of April 2021, a successor project was being planned. AFICAT activities can be started relatively soon by adding an AFICAT component and assigning experts to this project.

2) Formation of a new framework to start AFICAT activities

AFICAT will be operated on a trial basis and on a small scale within a new framework, with the aim of verifying whether it can function with the participation of the local government and Japanese companies in line with the proposed AFICAT action plan to be formulated through this survey. The specific tasks are as follows:

- Collection and dissemination of information necessary for the operation of AFICAT
- Coordination among Japanese companies and acquisition of materials and machinery
- Formulation and implementation of exhibition, verification, and demonstration plans
- Preparation of demonstration fields
- Coordination with the local government for the above
- Cost estimation of the AFICAT project

(3) Crops other than rice will also be targeted

As mentioned above, among the 112 Japanese agricultural machinery manufacturers, only 10 companies revealed their intention to expand the business into SSA[13]. Some agricultural machinery manufacturers are expanding their business in developing countries for crops other than rice. Although this depends on the type of crops targeted by the government agencies that have jurisdiction over AFICAT in the country, the possibility of using agricultural machinery and material manufacturers targeting crops other than rice in AFICAT should be considered to make AFICAT more active. Regarding crops other than rice, appropriate timing for inclusion in AFICAT activities must be considered, taking into account the priority crops in the country, nature of the work of government agencies that serve as AFICAT CPs, and progress of AFICAT activities related to rice. If AFICAT can actively publicize the results of JICA's private sector support program implemented by Japanese companies for crops other than rice, synergistic effects between such program and AFICAT can be expected.

(4) The seven functions of AFICAT will be revised

As confirmed through individual discussions with Japanese companies, the seven functions initially envisioned generally met the needs of the companies, although there were some differences in the interests of individual companies. In addition, as mentioned above, some companies wanted to receive financing for selling their products locally. Although it is difficult for AFICAT itself to provide finances, information on locally available finances can be collected and shared. In the future, AFICAT would promote the formation of JICA finance projects, such as two-step loan projects for purchasing agricultural machinery and materials and overseas investment projects towards local dealers or agencies of Japanese companies. Therefore, the survey team recommends including activities related to financing, in addition to the seven functions that were originally envisioned.

In addition to the verification and demonstration of individual products, the importance of verifying and demonstrating the entire business model and value chain was also pointed out by the interviewed Japanese companies. Although individual products are expensive, some Japanese companies would prefer to clarify the value of their products by building business models and covering a wide range of value chains. To emphasize importance, the survey team proposes to separate the functions "verification, and demonstration of the

[13] Eleven companies participated in the preceding survey; however, when the survey team re-interviewed some of the companies in this survey regarding their intentions to enter the SSA market, one company answered "No."

business model and value chain" from those of the product alone. Based on specific requests, the seven AFICAT functions were reviewed and revised, as shown in Table 2-4.

First, the original functions "(3) large-scale demonstration in the field" and "(4) postharvest processing and transportation" were integrated into a new function "(3) verification of the business model and value chain." Second, a new function "(4) Finance" was added. In addition, to sell expensive agricultural machinery, it is necessary to prove that the target crop can be sold at a price that is commensurate with its production cost. Demonstrating the entire value chain of the target crops, such as rice, under AFICAT may allow us to verify the feasibility of the agricultural machinery business.

Table 2-4 Revised seven functions of AFICAT (draft)

	Functions	Revision (draft)
1	Advice	Advice on the registration process for agricultural machinery and materials was added.
2	Exhibition, verification, and demonstration	No change
3	Large-scale demonstration in the field	Integrated into "verification of the business model and value chain" (including verification and demonstration in the field)
4	Postharvest processing and transportation	
5	Innovation lab	No change
6	Public relations	No change
7	Human resource development	No change
8	Finance	Added

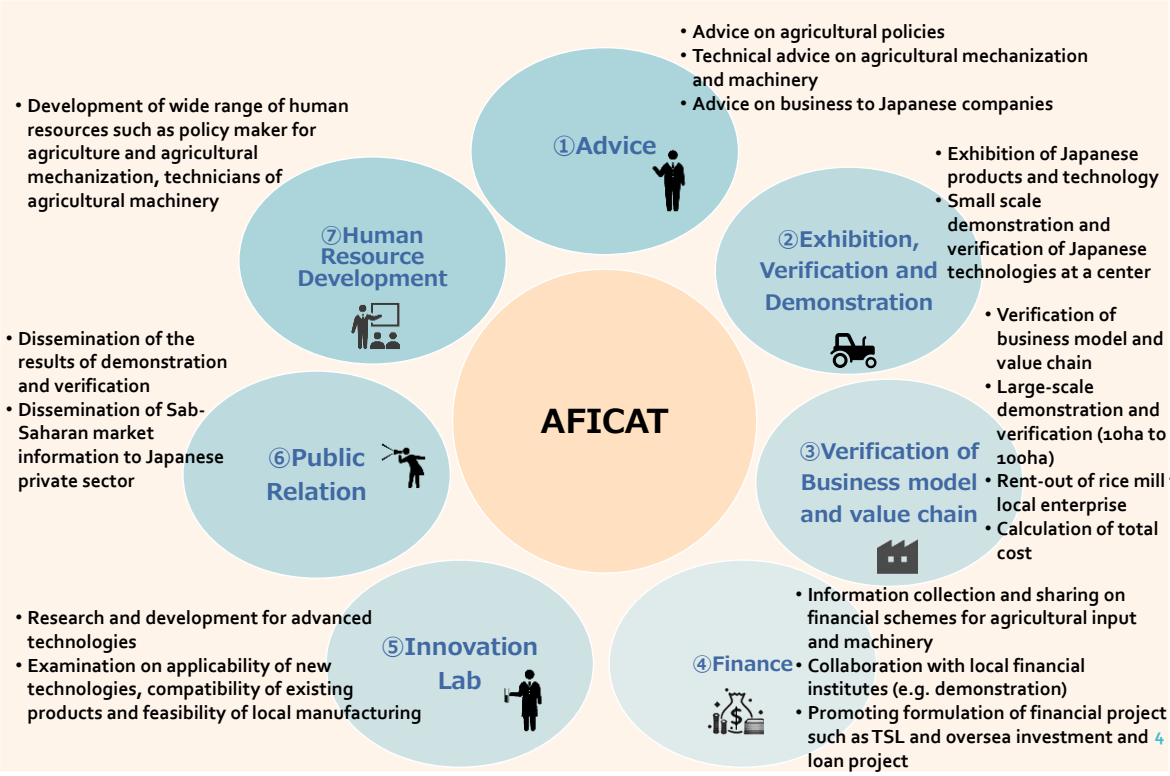

Figure 2-4 The seven functions of AFICAT (revised)

(5) A JICA technical cooperation project to promote AFICAT will be planned

Interviews with Japanese companies confirmed that it is difficult for Japanese company staff to stay for a long period at AFICAT for verification and demonstration. Therefore, in order for AFICAT to become operational, Japanese experts should be dispatched by JICA, at least at the initial stages of start-up and operation. In particular, to make AFICAT operational in countries other than those where relevant JICA technical cooperation projects are already underway or planned, new JICA projects must be drafted to promote AFICAT. In such countries, AFICAT can be operated on a trial basis within the abovementioned new framework, and the most effective approach to promote sustainable AFICAT function can be examined.

2.4. Seminars for Japanese companies

The following seminars on AFICAT were conducted for Japanese companies to invite them to participate in AFICAT. As the survey team continued discussions with Japanese companies, including those in the preceding survey, the survey team observed that the companies' interest in the SSA market have been increasing. Even after the full-scale implementation of AFICAT, organizing annual or biannual seminars for Japanese companies and online workshops connecting Japanese companies with local government officials is recommended according to the progress of AFICAT.

2.4.1. Online seminar with Tanzanian government officials

On November 18, 2021, an online seminar with government officials in Tanzania, one of the countries where AFICAT will be established, was conducted[14]. The outline of this seminar is as follows.

- Title: Establishment of AFICAT and Promotion of Agricultural Mechanization in Tanzania
- Date and time: November 18, 2021, Thursday from 15:00 to 16:30 (Japan Standard Time)/from 9:00 to 10:30 (East Africa Time)
- Venue: Zoom webinar
- Number of participants: 103 (excluding presenters and organizers)
- Program: The program is summarized in Table 2-5.

Table 2-5 Program of the online seminar

	Content	Presenter
15:00~	Opening remark	Mr. Sinjiro AMAMEISHI (Economic Development Department, JICA HQ)
15:05~	Conception of AFICAT	Mr. Yuichi MATSUSHITA (Economic Development Department, JICA HQ)
15:10~	Outline of the AFICAT plan and the agriculture sector in Tanzania	Ms. Fumiko IKEGAYA (Kaihatsu Management Consulting, Inc.)
15:25~	< Presentation from the Tanzanian government 1> Current status of agricultural mechanization and measures and expectations from the Japanese companies	Eng. Anna G. Mwangamilo Acting Director, Agricultural Mechanization and Irrigation, Ministry of Agriculture
15:40~	< Presentation from the Tanzanian government 2> Role of the Department of Agricultural Training Extension Services, and Research	Dr. Mashaka Mdangi Assistant Director, Agricultural Training, Extension Services, and Research, Ministry of Agriculture

[14] This online seminar was co-hosted by the JiPFA Africa Food Value Chain Subcommittee (eighth meeting), JiPFA Agricultural Mechanization Subcommittee (seventh meeting), and Africa Subcommittee of the Global Food Value Chain Promotion Public-Private Council (MAFF) and considered a side event of the Africa Public-Private Economic Forum.

	Content	Presenter
15:50~	< Presentation from the Tanzanian government 3> Outline of KATC	Eng. Nicodemus Shauritanga, Principal, Kilimanjaro Agriculture Training Center
16:00~	How to proceed with AFICAT?	Mr. Yuichi MATSUSHITA (Economic Development Department, JICA HQ)
16:05~	Q&A	Mr. Hiroshi OKABE (Kaihatsu Management Consulting, Inc.)
16:30	Closing remarks	Mr. Kentaro AKUTSU JICA Tanzania Office

Source: Survey team

Questions from participants were accepted three times, before, on the day of, and after the seminar, and the Tanzanian speakers mainly answered each question. After the seminar, 51 people responded to the questionnaire. To the question "Do you intend to participate in AFICAT?," 19 respondents answered "Yes, I would like to participate" and 28 answered "I would like to consider it/I don't know"[15]. In response to the question, "Would you like to have an individual interview regarding the use of AFICAT in the future?," 18 respondents answered "Yes."

2.4.2. Others

In addition to the above, information on the progress of the survey and the AFICAT plan were shared through JiPFA, as summarized below.

Table 2-6 Seminars on AFICAT

	Date	Outline
1	August 4, 2020	The concept (draft) of AFICAT was presented in an online seminar co-hosted by the JiPFA Africa Food Value Chain (FVC) Subcommittee (fifth meeting), JiPFA Agricultural Mechanization Subcommittee (third meeting), Africa Subcommittee of the Global Food Value Chain Promotion (GFV) Public-Private Council (MAFF), and Agriculture Working Group of the African Business Council.
2	August 6, 2020	The draft concept of AFICAT was shared at an opinion exchange meeting with development consulting firms on the co-creation cycle of agricultural technology and agricultural human resources (agricultural co-creation hub) at JICA, Tsukuba.
3	February 17, 2021	The draft concept of AFICAT was presented in an online seminar co-hosted by the JiPFA Africa FVC Chain Subcommittee (sixth meeting), JiPFA Agricultural Machinery Subcommittee (fifth meeting), Africa Subcommittee of the GFVC Promotion Public-Private Council (MAFF), and Agriculture Working Group of the Africa Business Council.
4	September 17, 2021	The progress of the survey and the future plan of AFICAT were shared in an online seminar jointly organized by the JiPFA Africa FVC Subcommittee (seventh meeting), JiPFA Agricultural Mechanization Subcommittee (sixth meeting), Africa Subcommittee of the GFVC Public-Private Council (MAFF), and Agriculture Working Group of the Africa Business Council.

Source: Survey team

[15] Four respondents who answered that "I have no intention to participate" included consulting firms.

Chapter 3. Current Status of and Issues Related to Agricultural Mechanization in Ghana

3.1. Outline of the Agriculture Sector

3.1.1. Agriculture overall

In Ghana, 36.4% of the working population (2019) relies upon agriculture, which represents one of the key sectors for economic growth and poverty reduction. However, the share of agriculture in the total gross domestic product (GDP) decreased from 35.3% in 2000 to 17.3% in 2019, and the average growth rate from 2000 to 2019 was 2.3% in the agricultural sector compared to 8.6% in the service sector and 7.4% in the industrial sector[16]. Therefore, the country is rapidly moving away from agriculture.

Figure 3-1 Agroecological zones in Ghana

Source: MoFA (2019) Agriculture in Ghana – Facts and Figures (2018)

As shown in Figure 3-1, Ghana hosts diverse climatic zones, ranging from dry savannahs to wet forests. The coastal areas, particularly in the east, are warm and relatively dry, while the southwestern areas are hot and humid and the northern ones hot and dry. In the south, there are two rainy seasons, from March to July and from September to October, while in the north, there is only one rainy season, from May to October. Based on these climate patterns, agricultural production is divided into major and minor seasons[17].

The major food crops produced include cassava (20.85 million tons), yams (7.79 million tons), culinary bananas (4.69 million tons), and maize (2.31 million tons)[18]. Ghana is world's fourth largest producer of cassava (2019)[19]. The major cash crop is cocoa, some of which is processed into cocoa butter or paste, among other products, while most of it is exported as beans. In 2019, exports from Ghana reached USD 16.3 billion (1,796.4 billion yen)[20], with cocoa-related exports accounting for approximately USD 2.7 billion (297.6 billion yen; 16.6%) of the total[21].

3.1.2. Rice production

Rice is the second major grain following maize, and the domestic annual rice production doubled from 230,000 tons to 530,000 tons between 2009 and 2018 (in terms of white rice)[22]. Meanwhile, domestic rice consumption has been growing rapidly in recent years due to population growth, urbanization, and changes in eating habits, with annual per capita consumption reaching 45.7 kg in 2018, indicating an increase from 25.6 kg in 2009; however, since the domestic production rate is not consistent with the consumption rate, the country must rely on imported rice, which accounted for 61% (2018) of the domestic consumption. In this context, increasing rice self-sufficiency is one of the major challenges faced by the Ghanaian government in

[16] WB (web) World Development Indicator
[17] MoFA (2019) Agriculture in Ghana – Facts and Figures (2018)
[18] (Same as above)
[19] FAOSTAT
[20] Ghana Export Promotion Agency (2019) Annual Report - 2019
[21] FAOSATAT
[22] MoFA (2019) Agriculture in Ghana – Facts and Figures (2018)

terms of food security and foreign exchange.

Paddy fields in the country can be broadly classified into (i) rainfed lowland, (ii) rainfed upland, and (iii) irrigated lands. As shown in Table 3-1, 78.8% of the paddy fields are rainfed lowlands, which are responsible for 71.1% of the rice production.

Table 3-1 Area under the cultivation and paddy production in Ghana

	Rainfed lowlands	Rainfed uplands	Irrigated lands	Total
Paddy cultivated land (ha)	205,731	15,826	26,423	261,192
Percentage of total (%)	78.8	6.1	10.1	100.0
Paddy production (ton)	534,903	36,399	110,977	752,300
Percentage of total (%)	71.1	4.8	14.8	100.0
Average yield (ton/ha)	2.6	2.3	4.2	2.9

Source: FAO (2021) Rice Value Chain in Ghana

3.2. Outline of the major stakeholders

3.2.1. Ministry of Food and Agriculture (MoFA)

MoFA is the agency responsible for formulating and implementing policies and strategies for the agricultural sector. Under MoFA, a Chief Director and seven Technical Directorates are allocated. The Ghana Irrigation Development Authority (GIDA) is an independent organization under MoFA. The organizational chart of MoFA is shown in Figure 3-2.

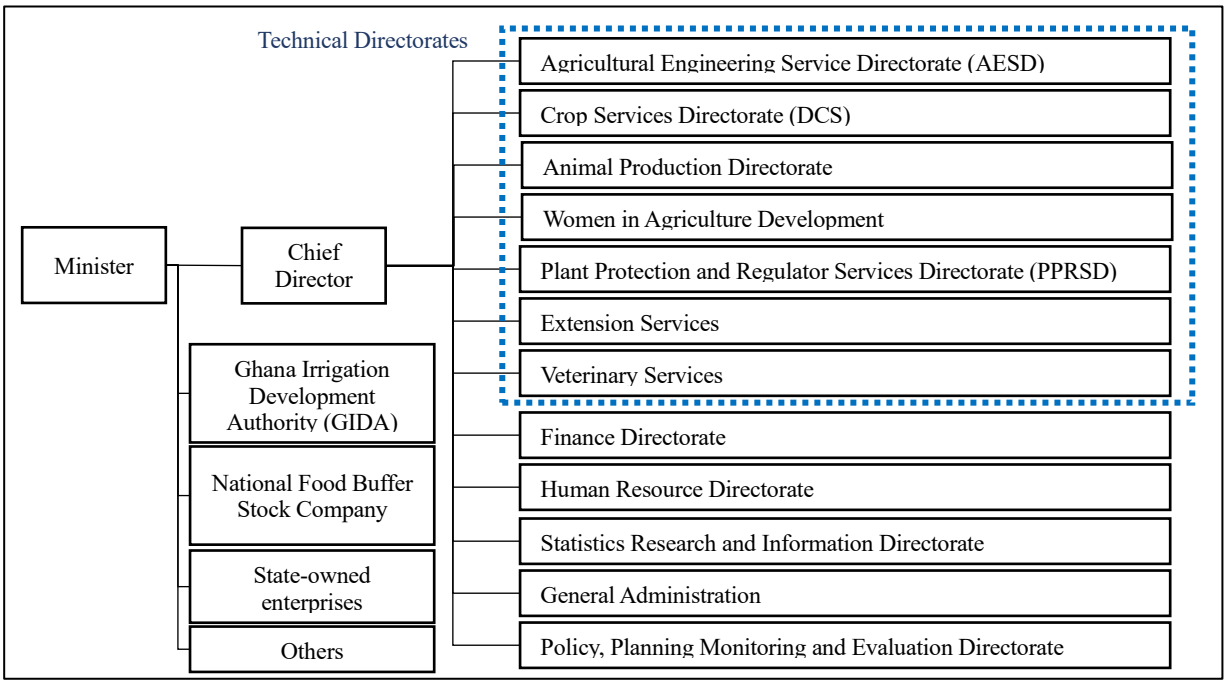

Figure 3-2 Organogram of MoFA

Source: Prepared by the survey team based on materials provided by MoFA.

(1) Directorate of Crop Service (DCS)

The mission of DCS is, for sustainable agricultural production, to enhance crop production for food, industrial purposes, and export as well as to promote processing, distribution, and marketing. DCS is also responsible for promotion of the crop sub-sector, including related policy formulation and distribution of

inputs, such as fertilizers and seeds. The organizational chart of DCS is shown in Figure 3-3.

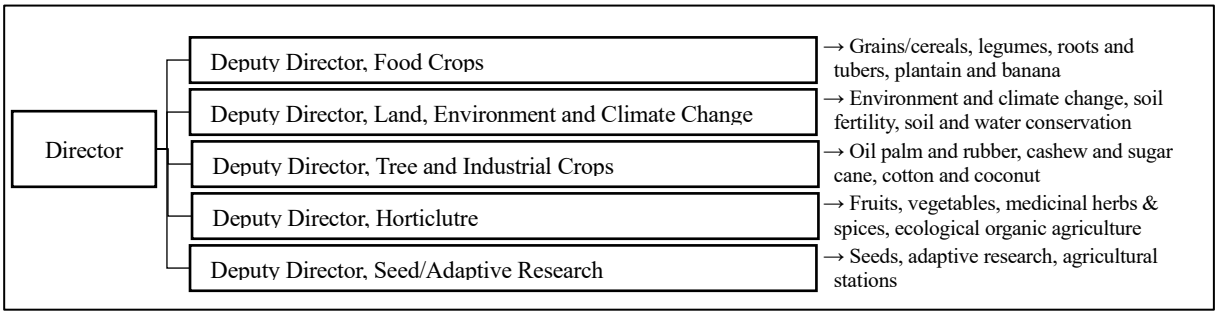

Figure 3-3 Organogram of DCS

Source: Prepared by the survey team based on materials provided by DCS

(2) Agricultural Engineering Services Directorate (AESD)

AESD is responsible for mechanization of the agricultural sector, including livestock and post-harvest processing. AESD is also responsible for the establishment and strengthening of the Agricultural Mechanization Service Enterprise Center (AMSEC). AESD is involved in the selection of agricultural machinery to be introduced by the Brazilian and Czech governments. The specifications and prices of machinery introduced by these governments are presented to the district offices via the regional office of the department, which then collects information on potential buyers and applies to AESD via the regional office. Due to decentralization, AESD is staffed only by the main ministry, with a total of 53 employees (including 23 support staff members, such as drivers). The organizational chart of AESD is shown in Figure 3-4.

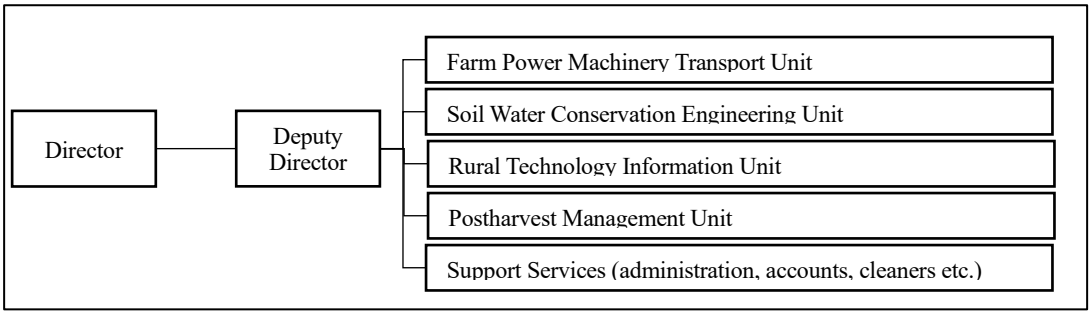

Figure 3-4 Organogram of AESD

Source: Prepared by the survey team based on materials provided by AESD

(3) Farm institutes under MoFA

MoFA has two farm institutes, which provide secondary education, namely the Adidome Farm Institute in Asuansi, Central Region, and the Wenchi Farm Institute in Wenchi, Bono Region. In the project to promote smallholder mechanization implemented by JICA from 2014 to 2015, training on agricultural machinery was conducted at the Adidome Farm Institute and Wenchi Farm Institute. The Adidome Farm Institute visited by the survey team has accommodation facilities, classrooms, and plots for students as well as agricultural machinery, including two tractors, combine harvesters, sprayers, and planters (some of which were introduced with the Japanese ODA). In addition to these secondary schools, MoFA has established agricultural colleges in Damango, Savannah (formerly Northern Province); Ohawu, Volta Province; and Ejura, Ashanti Province.

Entrance

Classroom

Accommodation

Two acres (0.8 ha) of irrigated field (Okra plantation)

Agricultural machinery

Agricultural machinery introduced by the Japanese ODA

Photograph 3-1 Adidome Farm Institute

3.2.2. Ghana Irrigation Development Authority

GIDA, a public corporation under MoFA, is responsible for designing irrigation-related facilities, implementing land use planning in the proposed irrigation development areas, offering and managing public irrigation facilities, and providing technical and management services for the effective utilization of irrigation facilities. GIDA is the CP agency of JICA's MASAPS-KIS project (Project for Enhancing Market-Based Agriculture by Smallholders and Private Sector Linkages in Kpong Irrigation Scheme), which had been implemented until June 2021, and its follow-up project, the Ghana Rice Production Improvement Project (GRIP).

3.2.3. Kwame Nkumah University of Science and Technology (KNUST)

KNUST was established in 1952 in Kumasi and comprises six colleges (agriculture, environment and architecture, social sciences, engineering, medicine, and science) and a graduate school. The Faculty of Mechanical and Chemical Engineering in the College of Engineering is in charge of agricultural machinery.

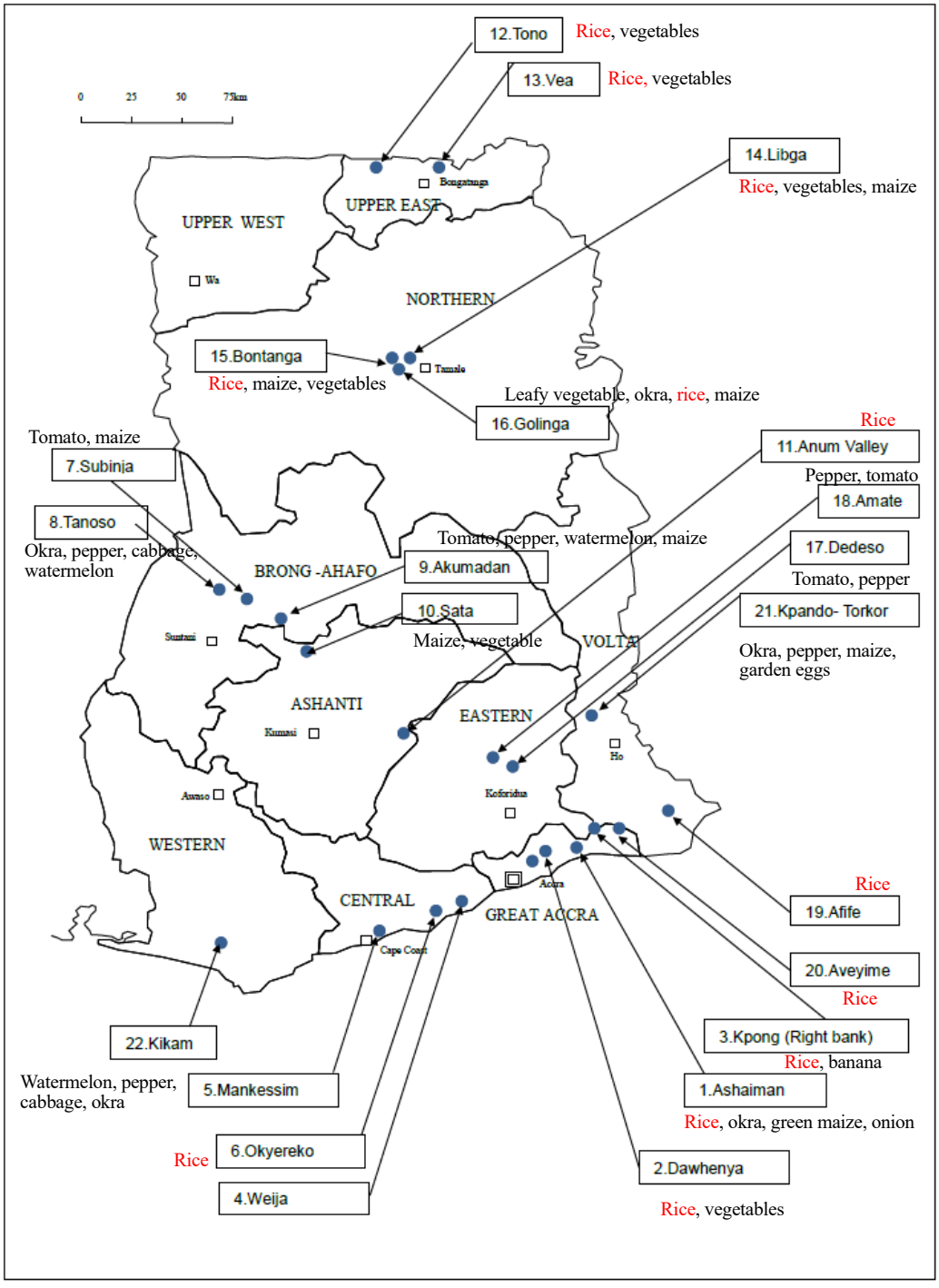

Figure 3-5 Irrigation scheme in Ghana

Source: Prepared by the survey team based on materials provided by JICA experts of MASAPS-KIS project

3.3. Related policies, strategies, and development plans

3.3.1. Agricultural mechanization policies and strategies

The Ghana Agricultural Engineering Policy and Strategy was introduced in April 2019 with support from the United Nations' Food and Agriculture Organization (FAO) and other agencies. It aims at improving the mechanical and technical skills of farmers involved at each stage of the value chains (crops, livestock, and

fisheries); strengthening the capacity of organizations through training, finance, and research; providing the necessary infrastructure; and applying methods for rapid yet sustainable agricultural growth while balancing the environmental and socioeconomic aspects.

In response to the current shortage of the supply of agricultural machinery suitable for crop production, the strategy provides incentives to farmers for the acquisition and use of agricultural machinery and supports the establishment of AMSECs. The strategy calls for the establishment of multiple AMSECs in individual districts (260 districts[23]) to prevent the monopolization of services. To address the lack of regulations and operational systems for importing agricultural machinery, the strategy includes the introduction of quality control regulations for imported agricultural machinery, establishment and operation of a national database for agricultural machinery, and strengthening of the capacity of agricultural machinery importers to provide after-sales service support.

3.3.2. National Rice Development Strategy (NRDS)

Formulated in 2009, NRDS sets ambitious targets to increase average paddy yield from 2.7 to 4.0 ton/ha, paddy cultivation area from 118,000 to 375,000 ha, and paddy production from 318,600 to 1.5 million tons between 2008 and 2018. However, the actual results in 2020 indicated that the average paddy yield was 2.88 ton/ha and the paddy cultivation area was only 261,192 ha. Although the paddy production has more than doubled since 2009, reaching 752,300 tons, it remains only half of the target value[24]. Moreover, in 2018, white rice production was 531,000 tons, while the imports were 830,127 tons, indicating that over 60% of the rice consumption relies on imports[25]. In this light, NRDS 2019-2030 is being formulated to promote paddy cultivation and rice self-sufficiency in the future.

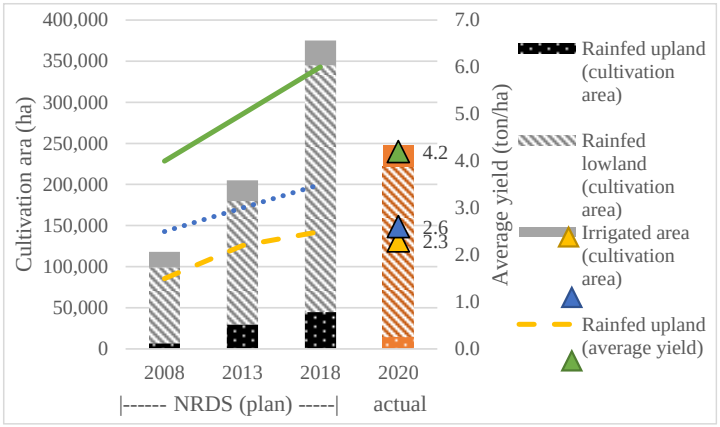

Figure 3-6 Planned and actual area and yield of NRDS (2009)

Note: The left axis shows cultivation area, and the right axis shows yield. The three bars on the left show planned values, and those on the far right show actual values.

Source: NRDS (2009) and FAO (2020) Rice Value Chain in Ghana

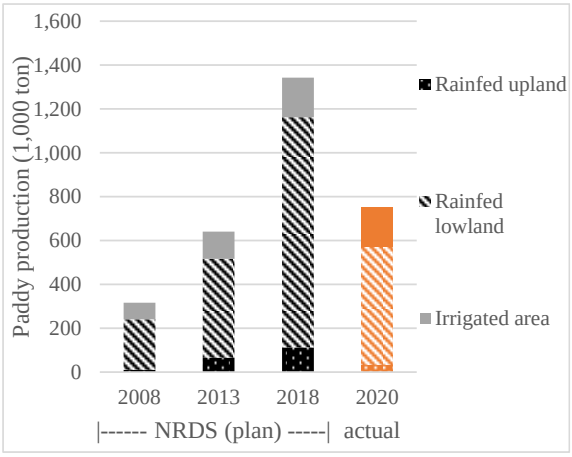

Figure 3-7 Planned and actual paddy production of NRDS (2009)

Note: The three bars on the left show planned values, and those on the far right show actual values.

Source: (Same as the left)

[23] Website of Ghana District (http://www.ghanadistricts.com/Home/AllDistricts)
[24] FAO (2020) Rice Value Chain in Ghana
[25] MoFA (2019) Agriculture in Ghana – Facts and Figures (2018)

3.3.3. Planting for Food and Jobs (PFJ[26])

PFJ is a flagship campaign launched in 2017 as an initiative by President Nana Akufo-Addo. It includes five modules, namely (i) Food Crop, (ii) Planting for Export and Rural Development, (iii) Greenhouse Technology Villages, (iv) Rearing for Food and Jobs, and (v) Agricultural Mechanization Services (AMSEC). The Food Crop module has five pillars: (i) dissemination of quality seeds, (ii) supply of fertilizers, (iii) extension services, (iv) marketing, and (v) e-Agri platform. Through this module, the government sells seeds and fertilizers to farmers at 50% subsidized price. In terms of rice production, the government has set a goal of achieving self-sufficiency by 2023.

Regarding agricultural machinery, the campaign states that small farm machinery will be sold to small farmers at subsidized prices, AMSECs will be strengthened and expanded, and at least one mechanization center will be established in each district. As shown in Table 3-2, agricultural machinery has been provided to the Ghanaian government through loan projects by the Brazilian (total amount of USD 95,495,000 or 0.5 billion yen) and Czech (total amount of EUR 10 million or 1.3 billion yen) governments. Tractors, threshers, tillers, and sprayers, among other equipment, are being sold to farmers, farmer groups, and AMSECs, with subsidies of 40–60% through AESD and local governments. The Indian government is also planning to support agricultural machinery on the scale of USD 150 million (16.5 billion yen).

Table 3-2 Agricultural machinery provided by the Brazilian and Czech governments through loans

	Introduction timing	Major machinery introduced	Amount
Brazilian government	First Tranche (2016)	Tractor with implements (528 units), multipurpose thresher (112 units), maize sheller (224 units)	USD 32.37 million (3.6 billion yen)
	Second Tranche (2018/19)	Power tiller (1,000 units), sprayer (4,000 units)	USD 32.40 million (3.6 billion yen)
	Third Tranche (plan)	n.a.	USD 30.73 million (3.4 billion yen)
Czech government	2019/20 年	Tractor (170 units), mini-tractor (300)	EUR 10 million (1.3 billion yen)
Indian government	(plan)	Machinery to strengthen AMSEC	USD 150 million (16.5 billion yen)

Source: AESD, MoFA

Yellow-green Czech tractors, Brazilian power tillers on the left

Brazilian threshers, threshing teeth are made of band steel with oscillating sheave

Reapers, an attachment type on the front of a Czech tractor

Photograph 3-2 Machinery stored by AESD

Source: Photographed by the survey team

[26] MoFA (2020) Operation Performance, PFJ 2017-2020

At the time of the survey, Brazilian power tillers, Brazilian threshers, Czech tractors, and Czech reapers attached to a tractor, as shown in Photograph 3-2, were observed in the premises of AESD. The Czech tractors were equipped with trailers, hammer mowers[27], and disk plows. The Czech-made tractor was CABRIO 50 hp 4 WD, which is a low-floor tractor. Low-floor tractors are often used in orchards and on slopes and are suitable for the production area of cocoa, which is a commodity crop. This tractor can also be equipped with a reaper using the power take-off (PTO) at the front of the machine[28]. The Czech product is mainly used in uplands, and to what extent the axles and other parts of the tractor are resistant to water when used in paddy fields remains to be tested[29].

3.3.4. Ghana COVID-19 Alleviation and Revitalization of Enterprises Support

Ghana COVID-19 Alleviation and Revitalization of Enterprises Support (CARE program) is a program designed in 2020 to combat COVID-19. Phase 1 aimed at economic stability and was implemented from June to December 2020. Phase 2 aimed at economic revitalization and transformation and will be implemented from 2021 to 2023. Phase 1 included support for the expansion of the PFJ program, which is a government program to support farmers. In addition to subsidies for seeds, fertilizers, and agricultural machinery, the addition of support for paddy milling machinery to the program was planned to meet the goal of achieving rice self-sufficiency by 2023. In phase 2, in addition to the above, the construction of rice storage facilities through public-private partnership is being considered.

3.4. Donor support

3.4.1. Supports from the Japanese Government including JICA

(1) JICA projects implemented in recent years

In Ghana, JICA technical cooperation projects have been implemented in both irrigated and rainfed rice cultivation areas, as shown in Table 3-3. In addition, for MoFA, AMSEC support and a project to improve MoFA financial management capacity have been implemented.

Table 3-3 JICA projects related to agriculture implemented in Ghana in recent years

Project name	Period	Implementing organization	Outline
Project for Enhancing Market-Based Agriculture by Smallholders and Private Sector Linkages in Kpong Irrigation Scheme (MASAPS-KIS project)	January 2016 to June 2021	Ghana Irrigation Development Agency (GIDA)	The project aimed to "increase agricultural production in the Kpong Irrigation Scheme (KIS)" by increasing the capacity of the implementing agency, the Ghana Irrigation Development Agency (GIDA), strengthening the capacity of water users' associations, increasing the productivity and profitability of rice cultivation, and promoting market-oriented agriculture.
Sustainable Development of Rain-fed Lowland Rice	April 2016 to May 2021	Directorate of Crop Service (DCS), MoFA	Phase 1 was implemented from 2009 to 2014 to improve farming and extension technologies for rainfed rice cultivation in nine pilot districts in

[27] Rotary mower mounted on a tractor

[28] Czech Republic produces rice,; however, whether the machinery is used to harvest wheat remains to be confirmed.

[29] Tractors for field crops can be used in paddy fields; however, if the axle parts are not greased frequently, this can cause early failure. Moreover, the performance of tractors and implement is greatly affected by the working conditions under which they are used. Therefore, it is difficult to show the suitability and superiority of agricultural machinery without accumulating detailed verifications.

Project name	Period	Implementing organization	Outline
Production Project (Tensui) Phase 2			Ashanti and Northern regions. Phase 2 aimed at the dissemination of rice cultivation methods based on the guidelines developed in phase 1 to 35 districts in Ashanti and Northern provinces.
Project of Smallholder Farmers' Access to Agriculture Mechanization in Ghana	April 2014 to August 2015	Agricultural Mechanization Service Enterprise Center (AESD), MoFA	AMSEC aims to strengthen agricultural mechanization services for small-scale farmers by setting the right timing and amount of money available for the introduction of agricultural machinery in the targeted areas.
Financial Management Improvement Project of the Ministry of Food and Agriculture	October 2010 to October 2015	MoFA	The project was implemented to improve the overall management cycle of MoFA in six areas: policy and budget, income and expenditure management, commitment management, asset management, performance evaluation, and internal audit.

(2) Planned JICA projects

As shown in Table 3-4, from 2021, a technical cooperation project will take over the two projects mentioned above: Project for Enhancing Market-Based Agriculture by Smallholders and Private Sector Linkages in Kpong Irrigation Scheme (MASAPS-KIS Project) and Sustainable Development of Rain-fed Lowland Rice Production Project (Tensui Project) Phase 2 as Ghana Rice Production Improvement Project (GRIP). In addition, CARD-related grant assistance (hereinafter referred to as the "CARD grant") is under consideration.

Table 3-4 Planned JICA project related to agriculture in Ghana

Project name	Period	Outline
Ghana Rice Production Improvement Project (GRIP)	From 2021 (5 years)	The project will contribute to increasing rice production in Ghana by improving the capacity of rice growers and strengthening the functioning of water users' associations, thereby increasing rice production in the target regions and irrigation schemes.

(3) Grant Aid for the Increase of Food Production/Grant Assistance for Underprivileged Farmers (2KR)

Since 2000, the following agricultural machinery has been provided to Ghana through the Second Kennedy Round (2KR [30]) of Grant Aid for the Increase of Food Production/Grant Assistance for Underprivileged Farmers.

Table 3-5 Machinery introduced in Ghana through 2KR (after 2000)

	2006	2008	2011	2014
Tractor	Landini (Italy): 40 units Same (Italy): 10 units	Kubota (Japan): 78 units	New Holland (Turkey): 125 units	New Holland (Turkey): 70 units
Power tiller	Kubota (Japan): 100 units			(Indonesia): 43 units
Rice mill	(Japan): 10 units	(Japan): 20 units	(Japan): 10 units	(Indonesia): 5 units
Water pump	(Turkey): 79 units	(Turkey): 16 units	(Japan): 49 units	

[30] 2KR was initiated in FY1977 as a derivative of Japan's Food Aid ("KR"), introduced in FY1968 under the Food Aid Covenant of the International Grains Agreement that was reached as part of the 1967 GATT-Kennedy Round (KR) tariff lump-sum negotiations. In the framework of KR, the Japanese government started providing funds to recipient governments to procure not only rice, wheat, and other foodstuffs but also agricultural materials and equipment required to increase food production.

	2006	2008	2011	2014
Thresher			(Indonesia): 35 units	(Indonesia): 35 units
Reaper			(Indonesia): 35 units	(Indonesia): 25 units

Note: Country of origin in parentheses

Source: JICA (2015) Expert on smallholder farmers' access to agriculture mechanization in Ghana – project completion report

3.4.2. Supports from other donors

Major projects related to rice cultivation by other donors are summarized in Table 3-6.

Table 3-6 Other donors' projects in Ghana

Project name/donor	Period	Outline
Ghana Commercial Agriculture Project (GGAP)/World Bank and USAID	2012 to December 2021	Rehabilitation and modernization of four irrigated areas with the goal of increasing agricultural productivity and production of smallholder and core farmers in the project intervention areas (the target irrigated areas include KIS). The main target crops included maize, rice, soybean, and vegetables. The total project cost was USD100 million (11 billion yen).
Public Private Partnership for Competitive and Inclusive Rice Value Chain Development/AGRA	July 2018 to June 2021	Targeting 14 districts in the Brong Ahafo Region and 6 districts in Northern Region, the project aimed to ensure food security and improve the livelihoods of smallholder rice farmers in the grain-producing area by increasing smallholder rice productivity, improving market access, and strengthening risk management for farmers and farming systems.
The Ghana Agricultural Sector Investment Programme (GASIP)/IFAD	2014 to 2021	The objective was to establish a financing framework and an institutional infrastructure to increase investment in pro-poor/smallholder agriculture value chains. As of March 2021, the second phase of the project is planned to be implemented. The main target crops included cassava, yam, and maize, in addition to rice. Total project cost was USD 77.99 million (8.6 billion yen).

Source: Prepared by the survey team based on websites of World Bank and IFAD and information collected during the field survey

3.5. Overview of agricultural mechanization

3.5.1. Current status of mechanization in rice-growing regions

The current status of agricultural mechanization in each type of rice-growing region, including rainfed lowlands, rainfed uplands, and irrigated lands, is described below.

(1) Rainfed lowlands

In rainfed lowlands, rice is cultivated using stream water flowing from springs and other water sources in the catchment area, in addition to rainfall. In the Ashanti Region, where JICA's Rainfed Rice Project 2 was implemented, rice is cultivated in rainfed lowlands. Here, only 20% of the land preparation work is performed using a power tiller and most of the harvest is completed manually by laborers[31]. The field plots are small, measuring 25 m × 40 m, and the plots are divided into 4 to 8 equal sections with temporary bunds. Smaller plots facilitate manual plowing and leveling works.

[31] According to CPs of JICA Rainfed Rice Project 2

(2) Rainfed uplands

Rainfed uplands are mainly distributed from central to northern Ghana. According to AESD, rice is one of the major cereal crops in rainfed upland areas, in addition to maize, sorghum, and millet, and it is produced through manual labor. However, as mentioned in Table 3-1, the area and production of rice in the uplands account for only 5% of the total. In particular, the production of rice is more dependent on rainfall than that of other field crops; thus, the future growth of rice production in rainfed uplands is expected to be limited.

Photograph 3-3 Manual puddling

Source: JICA's rainfed rice project 2

(3) Irrigated lands

Mechanization is more prevalent in irrigated areas than in other areas. In the KIS, Weta Irrigation Scheme, and Dawhenya Irrigation Scheme, which were visited by the survey team, tractors and power tillers are used for land preparation works (Photograph 3-4) and combine harvesters are used for harvesting works. This is primarily because the cost of using machinery is lower than the cost of labor in irrigated areas. For instance, the cost of manual reaping and threshing works in the Weta Irrigation Scheme is GHS 1,250(23,900 yen)/ha, while the cost of using combine harvesters is GHS 800–850(15,300-16,250 yen)/ha. In addition, the cost of using a combine harvester in KIS is GHS 1,000(19,120 yen)/ha, while the cost of manual harvesting works is double, at GHS 2,000 (38,240 yen)/ha. If harvesting conditions are good, a combine harvester can harvest a hectare field in 2 hours[32]. However, in all irrigation schemes, the number of agricultural machines is insufficient, and losses due to failure to harvest at the right time have been reported.

Photograph 3-4 Plowing with a disc harrow (Baldan), followed by dry direct seeding

Source: Survey team

Under the conditions of KIS described above, a service provider of combine harvesting would have gross income of GHS 80,000 (1.53 million yen) per season, based on the conditions of approximately 2 ha per day, 5 days per week, 2 months per season, 40 days per season, and 80 ha per season.

Harvesting lodged paddy

Bagging of grains

Most grains are at the milky stage

Photograph 3-5 Harvesting works in the KIS

Source: Survey team

[32] As explained by a farmer in the KIS who owns a combine harvester

According to interviews with farmers in KIS, a Chinese combine harvester (World Brand) was purchased in 2020 for GHS 180,000 (3.44 million yen) through a personal agent in Accra. Since many Chinese farmers have returned home due to COVID-19[33], the price as of March 2021 was GHS 200,000(3.82 million yen)[34].

As mentioned above, 2KR provided machinery, including equipment manufactured in other countries. Farmers and government officials experienced in using Japanese manufacturers' products confirmed in the survey that they highly appreciated the performance of the products[35]. In particular, for land preparation works under wet field (irrigated) conditions, direct puddling with power tillers is easy due to their simple operability and high durability. However, issues of the lack of availability of consumable parts after the granting of the products and lack of distributors that sell the products of Japanese manufacturers were pointed out and need to be addressed. Therefore, increased use of agricultural machinery manufactured by other countries is possible.

Most of the combine harvesters identified in March 2021, when the field survey was conducted, were made in China. As described below, combined harvesters made in India may be distributed in the future, although combine harvesters made by Japanese manufacturers have been not sold as yet. Undoubtedly, the use of combine harvesters will continue to increase in irrigation scheme areas visited in this survey. This is because the use of combine harvesters is cheaper than manual reaping and threshing, and combine harvesters manufactured in other countries are highly efficient, enabling harvest at the right time. With increased use of combine harvesters in the future, farmers are expected to demand machines with greater durability and operability but lower cost.

3.5.2. Service providers

Service providers include farmers who own agricultural machinery, people who own agricultural land but are engaged in other businesses (construction, processing, or civil services, among others), and corporations that specialize in their own business[36]. During the employment period, most of the machinery operators are paid at around 10–20% of the farm works. However, there are few skilled operators, the lack of basic knowledge of the machinery, ignorance of routine inspection, and overzealous operation are some of the major causes of agricultural machinery breakdown[37].

To promote agricultural mechanization by the private sector, the Ghanian government has been implementing the AMSEC program since 2007, which encourages the establishment of AMSECs. As a result, 167 AMSECs have been established nationwide by March 2021. However, according to the AESD, 17% of them are not operational, as shown in Table 3-7, due to inadequate management as a service provider, lack of business capital, and lack of operators and mechanics.

In addition to AMSEC, there are some agricultural machinery service providers for farmers. The machinery service providers' association has been established in KIS to set service charges for the use of

[33] Japanese living in Accra
[34] Farmers in the KIS (representatives of water users association)
[35] These include farmers in Kpong and Dawhenya Irrigation Scheme, AESD staff (former JICA participants), Ashanti Regional Agricultural Office staff, and GIDA staff, among others.
[36] Former JICA experts
[37] Project of Smallholder Farmers' Access to Agriculture Mechanization in Ghana, JICA Final Report

machinery and to promote efficient operations. In fact, however, the number of machines is inadequate to meet the current demand, because some machines are out of order or under repair or their spare parts are not available.

Table 3-7 Number of AMSECs established and operational status

Region	Operational		Non-operational		Total	
	Number	%	Number	%	Number	%
Ashanti	12	80	3	20	15	100
Brong Ahafo	14	70	6	30	20	100
Central	8	89	1	11	9	100
Eastern	16	67	8	33	24	100
Greater Accra	9	82	2	18	11	100
Northern	49	100	0	0	49	100
Upper East	6	67	3	33	9	100
Upper West	8	80	2	20	10	100
Volta	14	82	3	18	17	100
Western	3	100	0	0	3	100
Total	138	83	28	17	167	100

Source: Prepared by the survey team based on documents from AESD, MoFA

TROTRO Tractor Co., as discussed later, has started a business to provide efficient agricultural services to farmers. Such efforts allow the service providers to know in advance when, where, and how much demand there will be for their machinery services. This is advantageous to farmers, who can decide in advance when they want to work on their farms and receive agricultural machinery at that time.

3.5.3. Challenges and needs of agricultural mechanization

In irrigated areas, the feasibility of two cropping seasons, a major and a minor season (or even 2.5 cropping seasons with the use of early maturing varieties) can allow for increasing rice production. However, the shortage of farm laborers and number of machines is a major factor that delays work planning, and the inability to work at the right time reduces productivity.

Photograph 3-6 Unevenness of seedlings sown by wet direct seedling in KIS

Source: Survey team

During land preparation and harvesting works, due to increasing the labor costs, irrigated areas that traditionally used manual rice planting methods are shifting to labor-saving systems, such as wet and/or dry direct seeding methods. However, the direct seeding methods are performed by laborers using a manual broadcasting method, resulting in uneven sowing, which decreases production. According to JICA experts and Ghanian staff of the KIS project, there are “service groups” that undertake manual rice transplanting; however, this method is practiced in only 30% of the total rice-growing areas in KIS, and manual transplanting works are becoming less common every year. Under the project, farmers were trained to practice the wet direct seeding method (manual broadcasting) and manual rice transplanting method after direct puddling; in recent years, however, some farmers have been following the

dry direct seeding method using disc harrows for plowing, harrowing (pulverizing clod work), and soil covering.

In the Dawhenya Irrigation Scheme, after direct puddling under land preparation works, the wet direct seeding method accounts for 90% and manual rice transplanting for 10% of the works[38]. The service charge for direct puddling is GHS 1,000 (19,120 yen) /ha for both tractors and power tillers.

Furthermore, in Weta Irrigation Scheme in the Volta region, most of farmers practice the dry direct seeding method, which costs GHS 425 (8,130 yen) /ha for plowing with a disc plow, GHS 425 (8,130 yen) /ha for harrowing with a disk harrow, and manual broadcasting of seeds and soil covering with a disk harrow[39]. In other words, the total cost of plowing, harrowing, seeding, and covering is GHS 850 (16,250 yen) /ha. Some farmers in the scheme use only a disc harrow for plowing. The cost of plowing with a disc harrow is GHS 250 (4,780 yen) /ha, and the cost of harrowing, manual seeding, and soil covering with a disc harrow is GHS 425 (8,130 yen)/ha; thus, in this case, the total cost is GHS 675 (12,910 yen) /ha. Considering the direction of mechanization, the optimal work system (dry direct seeding, wet direct seeding, or mechanical transplantation) that can be standardized and expanded in irrigated rice-growing regions in the future should be verified.

As mentioned above, rainfed rice growing regions are divided into two types, namely rainfed uplands and lowlands. Rice cultivation in rainfed uplands follows the same dry direct seeding work as in irrigated lands, although the difference in annual productivity is larger because of dependence on rainfall. In rainfed uplands, poor drainage prevents harvesting with wheel-type combine harvesters, necessitating the use of crawler-type combine harvesters[40]. According to the CPs of the Rainfed Project 2 (Kumasi, Ashanti), rice transplanting work is recommended in rainfed lowland areas to ensure a stable yield, as water can be sourced from streams during the rainy season. However, since the timing and amount of rainfall are uncertain even when preparing seedling beds, the use of agricultural machinery, particularly driven-type power tillers, is essential to work at the right time and expand the rice production area.

Photograph 3-7 New Holland TT4030 tractor (left) and rotary (FIELDKING) to be attached to the tractor (right)[41]

Source: Survey team

After threshing, paddy grains are sun-dried in both irrigated and rainfed areas. The grains are spread

[38] Explanation by former JICA participants and staff in charge of machinery working in the Dawhenya Irrigation Scheme
[39] Disc harrows are also used for covering soil.
[40] AESD staff
[41] L-shaped rotary blades for direct puddling work (Dawhenya Irrigation Scheme)

out on sheets, a canvas, or a concrete pavement (as drying yards); the spread grain layer is thin (around 1 cm). Due to direct sunlight, grains are dry very rapidly. If the drying speed of the paddy is fast, the grains (or more precisely, brown rice) crack (grain cracks are caused by very rapid drying, not over-drying). The cracked grains yield broken rice regardless of the use of excellent milling equipment[42].


Photograph 3-8 Drying yards in the Dawhenya Irrigation Scheme (left) and KIS project areas (right)[43]

Source: Survey team

During the survey, the team confirmed that all rice milling machines were made in China. Some rice mills lacked pre-cleaners, but all were equipped with destoners; in such cases, the efficiency of stone removal is extremely low. Many small-scale rice mills use a 6-inch single-pass (one-pass) rubber roll husker and a friction-type whitening machine (short-process type); thus, a high amount of long, uncracked grains break (reducing frictional resistance leaves a bran layer).

Photograph 3-9 Husker (top) and short-process type whitener (bottom) (in Kumasi)

Source: Survey team

In Dawhenya Irrigation Scheme, the rice milling plant purchased in 2020 costed GHS 1.3 million (24.85 million yen)[44]. The mill comprises a pre-cleaner, a destoner, a husker (10 inch), single-pass abrasion and two-pass friction-type whitening machines, and a sizing machine[45] (round perforated seat, categorized as a width separator).

[42] Thickness of grain layer during sun drying should be 5 cm, and grains should be constantly stirred under direct sunlight.
[43] Impurities are removed with a blower.
[44] GIDA staff
[45] A sizing machine is used to separate grains; it can be applied to not only rice but also other cereals and can separate grains by length, width, and thickness. Most of the commonly used sizing machines have an oscillating width-type separator. However, in this width separator, head rice (unbroken rice) is also separated as broken rice if the grain stands up due to the vibration of the oscillating movement. This type of machines are called as graders. This is a confusing term in that grade describes the quality of products, and separating broken rice is one of the ways to increase rice quality.


Paddy separator


Abrasion and two-friction type whitener


Sizing machine (front side)

Photograph 3-10 Rice mill in the Dawhenya Irrigation Scheme

Source: Survey team

The retail price of paddy grains is GHS 180–220 per bag (90 kg); however, a bag is considered to be 90 kg and sold without being weighed. Some rice farmers borrow money from the brokers, the so-called aggregators, at the beginning of the cropping season to use agricultural machinery and buy fertilizers or other inputs. The repayment is in goods (paddy grains), which are often purchased at a lower price. The rice mills surveyed here were custom-type, although some of them bought paddy grains directly from rice farmers.

In general, the milling charge is based on the total amount of white rice obtained after milling, and according to the rice millers, the milling charge is determined by GIDA. There are 22 rice mills in the KIS region, and the milling charge is constant, at GHS 8 (150 yen) per 50 kg of white rice, that is, GHS 0.16 (3 yen) / kg of white rice. Rice mills in the area use a can to weigh white rice after milling and consider 16-17 cans to be 50 kg. Meanwhile, in the Dawhenya Irrigation Scheme areas, the milling charge is GHS 15 (290 yen) per 85 kg of paddy grains. According to the rice millers' explanation, 85 kg of paddy grains yield 50 kg of white rice, indicating 59% milling recovery. In other words, 50 kg of white rice costs GHS 15; thus, the milling charge is GHS 0.3 (6 yen) for one kg of white rice, which is nearly two times expensive compared with the charge in the KIS area. Rice bran belongs to the millers, and they sell it at GHS 15 (290 yen) per 50 kg.

The wholesale price of white rice from the rice mills is GHS 220 (4,210 yen) per 50 kg; thus, the price of 1 kg of white rice is GHS 4.4 (84 yen). In a local market in Accra, white rice and parboiled rice were sold by two different measuring cans. Packaged white rice is labeled with different brand names and not sold under the rice variety name. Rice is packaged as 5 kg or 25 kg bags, and the selling price of 1 kg of white rice is approximately GHS 6–8 (115–150 yen). At supermarkets in Accra, rice from Thailand, Vietnam, India, and other countries was on sale. The price of Jasmine rice from Thailand was GHS 16 (310 yen) /Fi kg. In Ghana, aromatic rice, whether domestic or imported, is preferred.

3.5.4. Sales and prices of agricultural machinery from overseas manufacturers

In this survey, the team confirmed the status of distributors for John Deere, Massey Ferguson, and New Holland, which are the world's three major agricultural machinery manufacturers.

TATA AFRICA Holdings is a distributor for John Deere and FIELDKING. TATA started selling John Deere products in 2018; until then, they were handled by other distributors. FIELDKING crawler-type combine harvesters have recently become available for sale in response to customers' demands, and the distributor intends to sell them in the northern areas where mechanization is lagging. One of the challenges in

the northern area is harvest in poorly drained fields, and combine harvesters are excellent for working in muddy fields. Table 3-8 shows the prices of agricultural machinery sold by TATA[46].

Table 3-8 Agricultural machinery prices at TATA Africa Holdings Gh. Ltd.

John Deere	Price
5075E Tractor (75 hp)	USD 32,500
5065E Tractor (65 hp)	USD 29,000
5055E Tractor (55 hp)	USD 18,000
DP1002 2-disc plow	USD 1,200
Boom sprayer	USD 8,200
3-Row planter	USD 11,400
4-Row planter	USD 14,300
Rovic Leers	
Chisel plow with roller, width 1.5 m	USD 6,500
Chisel plow with roller, width 2 m	USD 5,500
Slasher 4-blade, width 1.5 m	USD 3,400
FIELDKING	
Slasher (New product)	USD 3,500
3-Disc plow (New product)	USD 2,650
5-Disc plow (New product)	USD 4,200
Subsoiler	USD 2,300
20-Disc harrow	USD 3,400
Rotary	USD 4,000
Fertilizer spreader (400 L)	USD 1,200
Fertilizer spreader (250 L)	USD 750
Disc ridger	USD 2,550
Trailer (3-way tipping)	USD 10,300
Hydraulic harrow (22-disc)	USD 8,500
Boom sprayer	USD 5,000
Combine harvester, reaping width 2.2 m	USD 38,000

Source: Prepared by the survey team based on stock items and interviews

Photograph 3-11 Distributed agricultural and construction machinery (TATA)

Source: Survey team

Mechanical Lloyd Ltd. is an official dealer of Massey Ferguson with offices in Accra and Tamale, but they do not import used machinery and sell only new products. Since Massey Ferguson is widely popular in Ghana, individual agents and other distributors also sell new and imported used products. Regarding farm equipment, the company sells GALUCHO products, such as disc plows, disc harrows, rotaries, and trailers recommended by Massey Ferguson.

CFAO sells JCB (a British heavy machinery manufacturer), FUSO, Toyota forklifts, and

[46] Only TATA could provide the price list (stock item) of agricultural machinery in this survey.

Bridgestone tires, among others. The company has branches in Tema, Kumasi, Takoradi, and Cape Coast and has also set up a base in Tamale. They used to sell New Holland tractors but have not sold these in the past two years (no dealership). However, since they had sold over 50 agricultural New Holland machines to MoFA a few years ago, they have been following up with the agency by providing spare parts. According to the company explanation, they suspended their New Holland dealership because the Ghanaian government has been buying New Holland machinery directly from overseas, without going through dealers.

3.6. Agriculture inputs (seeds, fertilizers, and agrochemicals)

3.6.1. Seeds

In Ghana, three main varieties of rice seed (fragrant rice), namely JASMIN85, AGRA, and EX-BAIKA (Legon 1), are widespread[47]. The Council for Scientific and Industrial Research-Soil Research Institute (CSIR-SRI) maintains the breeder seed (BS) for JASMIN85, the Council for Scientific and Industrial Research-Crop Research Institute (CSIR-CRI) maintains the BS for AGRA, and the University of Ghana does maintains the BS for EX-BAIKA. Foundation seed (FS) is produced by research institutions, private companies (e.g., RMG), and irrigation districts (e.g., KIS), which are certified as FS producers. Certified seed (CS) is produced by CS farmers. Following CS certification by the Plant Protection & Regulatory Services Directorate-Ghana Seed Inspection and Certification Division (PPRSD-GSID) of MoFA, CS is sold to rice farmers through the PFJ program or directly sold to rice farmers by CS farmers.

Photograph 3-12 Warehouse for CS in KIS

Source: Photographed by the survey team

If new seeds are for sale in Ghana, they must be registered with the PPRSD-GSID, which requires a verification test (minimum 2 years) at the CSIR-CRI and CSIR-SRI. PPRSD-GSID and CSIR-CRI recommend partnering with a local company to sell new seeds. CSIR-CRI recommends that companies conduct a needs survey, grow the new seed, and sign a license agreement with CSIR-CRI to sell the new seed in Ghana.

3.6.2. Chemical fertilizers

Soils in Ghana are diverse, and different regions and crops require different fertilizer components. In the past, NPK (nitrogen–phosphate–potash) 15:15:15 was commonly applied; at present, however, an NPK blend is recommended to suit the local soils. In 2018, 383,054 tons of chemical fertilizers were imported[48]. Excessive chemical fertilizer

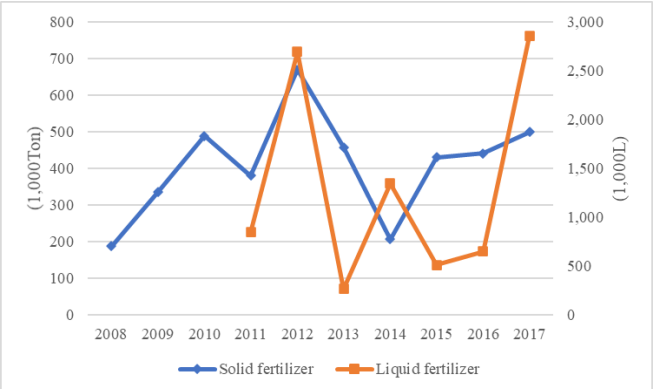

Figure 3-8 Trends in import volume for chemical fertilizer (solid, liquid)

Source: Prepared by the survey team on MoFA (2019) Agriculture in Ghana Facts and Figures

[47] "Togo marshak" is popular in Weta Irrigation Scheme.

[48] MoFA (2019) Agriculture in Ghana Facts and Figures. Of the 383,054 tons of imported chemical fertilizers (solid), 224,176 tons were NPK.

application is a problem in KIS, as it impedes crop growth. If new fertilizers are to be sold in Ghana, they must be registered with the Plant Protection & Regulatory Services Directorate-Plant Quarantine Services and Pesticides and Fertilizer Regulatory Division (PPRSD-PFRD), which requires a verification test (one year in the south with two cropping seasons and two years in the north with one cropping season) at CSIR-SRI. Although the use of liquid fertilizers has started Ghana, solid fertilizers are remained mainstream. Chemical fertilizers are commonly supplied for trace elements, such as zinc, sulfur, and copper.

3.6.3. Organic fertilizers

Organic fertilizers are sold by Farmers Hope, Green Fertilizer (both are local companies), and FERM O FEED (Dutch company). The demand for organic fertilizers has been gradually increasing. Farmers Hope produces 20,000 bags (50 kg/bag) per year, but it is not enough to meet the demand. Organic fertilizers are also eligible for subsidies under the PFJ program (see below for details).

Farmers Hope was established in 2009 and officially registered in 2010. The organic fertilizer of the company is the only and the first one to receive international certification from the International Federation of Organic Agriculture Movements Organics International (IFOAM)[49] in Ghana. This organic fertilizer is composed of antibiotic-free chicken manure, rice husks, and cocoa hulls. This organic fertilizer is sold at a price of GHS 70 per 50 kg.

Chemical fertilizer sold at a local agriculture material shop


Organic fertilizer produced by Farmers Hope

Photograph 3-13 Chemical and organic fertilizers sold in Ghana

Source: Photographed by the survey team

3.6.4. Agrochemicals

Various agrochemicals are used in Ghana. For instance, herbicides are applied once before land preparation, and additional fungicides are applied after land preparation and direct puddling in KIS. According to KIS project experts, blast is a severe issue, which frequently occurs during the minor season. Natibo from Bayer (Germany) is used against blast. However, the lack of stable supply is a problem.

As of 2015, 171 insecticides, 53 fungicides, and 143 herbicides were registered with the Environmental Protection Agency (EPA)[50]. The countries of origin of pesticides sold by Dizengoff Ghana, a distributor of agricultural machinery and materials, included the Netherlands (Sineria) and China (Rainbow). According to RMG, pesticides and fertilizers made in China have been used in Ghana, and price competition has become more severe.

[49] IFOAM website (https://www.ifoam.bio/)
[50] EPA (2015) Revised Register of Pesticides

Table 3-9 Varieties, prices, and countries of origin of agrochemicals sold by Dizengoff Ghana

Variety	Name	Price (GHS)	Country of origin
Insecticide	SEEDPOWER 44WS	- (200 g)	Sineria (The Netherland)
Insecticide/miticide	PROTECT 1.9EC	GHS 15.5/100 mL GHS 29/200 mL GHS 70/500 mL	
Insecticide/miticide	MEKTIN1.8EC	GHS 98/1,000 mL	
Insecticide	GOLAN SL	GHS 34/250 mL GHS 129/1,000 mL	
Insecticide	Defiance 4.8%	GHS 23/200 mL	
Insecticide/miticide/ nematicide	ORIZON	GHS 146/1,000 mL	
Botanical insecticide	LEVO2.4 SL	GHS 48/200 mL	
Herbicide	DIZ-PARAQUAT	GHS 20/1,000 mL	Rainbow (China)

Source: Survey team

If a new pesticide is to be sold, it must be registered with the EPA. EPA registers, manages, and imports pesticides and issues a permit for use. PPRSD-PFRD monitors the distribution and efficacy of registered pesticides. PPRSD-PFRD also mandates monitoring the sale of unregistered pesticides.

3.6.5. PFJ program

Through the PFJ program, farmers can purchase fertilizers and seeds at low prices. Under the PFJ program in 2021, the price was GHS 48 per 25 kg for chemical fertilizers other than urea, GHS 25 per liter for liquid organic fertilizer, GHS 55 per 25 kg for granular organic fertilizer, GHS 25 per 50 kg for compost, and GHS 5 per kg for rice seed (CS)[51]. RMG sells rice seeds to farmers through its own sales network under the PFJ program. The official price of rice seeds in 2021 set by the PFJ program was GHS 8/kg. Since RMG sells the rice seeds to farmers at GHS 5/kg, GHS 3/kg is subsidized. In addition to grain seeds, such as rice and soybeans, vegetable seeds are also covered under the PFJ program[52]. Foreign companies can participate in the PFJ program as long as they are registered under Ghana's Companies Act. By establishing a local subsidiary, Japanese companies can sell fertilizers and seeds using the PFJ program.

3.7. Advanced agricultural technologies

3.7.1. Drones

In Ghana, drones have already been used in the agriculture sector. According to Drone Hub Ghana, a company that sells drones locally, drones are being used in the agricultural sector for (1) spraying pesticides and liquid fertilizers, (2) mapping (measuring field area), (3) security (monitoring the field to prevent theft), and (4) checking the status of growth. In particular, (1), (2), and (3) are

Photograph 3-14 Drone made in China

Source: Photographed by the survey team

[51] MoFA (2021) 2021 PFJ APPROVED INPUTS PRICES

[52] The varieties of vegetable seeds that are covered by the PFJ program and their prices are as follows: tomato: GHS 35/100 g, pepper: GHS 50/100 g, onion: GHS 45/100 g, cabbage: GHS 200/100 g, cucumber: GHS 40/100 g, lettuce: GHS 60/100 g, carrots: GHS 38/100 g.

widespread in Ghana. The price of drones depends on the capacity of the tank and the battery. The price range with the most sales is between USD 12,000 and USD 20,000.

According to Drone Hub Ghana, drones are necessary for farmers to improve cost efficiency and these can be even more efficient when linked to mobile devices. Drone Hub Ghana also mentioned the necessity of a dedicated power generator for drones to carry larger capacity tanks, run for a longer period, and provide drone services in rural areas.

3.7.2. Agricultural applications

Applications that match the various service needs of farmers are becoming widespread in Ghana.

(1) TROTRO Tractor

TROTRO Tractor is a company that develops and operates a platform that connects farmers with both service providers and tractor operators offering cultivating services. As of March 2021, the company has registered 628 tractor operators, 433 tractors available for rent, and 252 farmer-based organizations (FBOs). An area of 13,059 acres has been cultivated through services provided by TROTRO Tractor. When companies register their tractors with TROTRO Tractors, they must install GPS, which costs GHS 800/unit. GPS allows TROTRO Tractor to track the tractors in real-time and switch off the engines if farmers misuse them. In addition to this, the company allows users to request a tractor service via USSD (shortcode) without a smartphone and to pay fees with mobile money.

(2) Agrocenta

Agrocenta has developed and operates two platforms: "Crop Chain," which connects farmers and buyers, and "Lend it," which facilitates farmers' access to finance.

"Crop Chain" allows farmers to sell their crops without brokers, enabling buyers to readily buy crops at a lower price. "Lend it" partners with financial institutions to provide small loans to farmers and with insurance companies to provide weather insurance.

3.8. Access to finance

The financial sector in Ghana constitutes four tiers, except for the Universal Bank, which is represented by the Commercial Bank[53]. The financial institutions classified as tier 1 and 2 can provide loans and other services in the same manner as commercial banks. However, the services are more limited in tier 4. For instance, Susu Collectors classified as tier 4 can only provide deposits (savings)[54]. The Bank of Ghana is the supervisory authority for all financial institutions, and rural and community Banks are supervised by ARB Apex Bank Limited. They act as the central bank for the rural and community banks and are responsible for the provision of loan resources and fund management.

[53] World Bank (2016) Ghana's Microfinance Sector: Challenges, Risks and Recommendations
[54] JICA (2020) Study on Innovative Financial Inclusion Approach in Agriculture and Health Sector

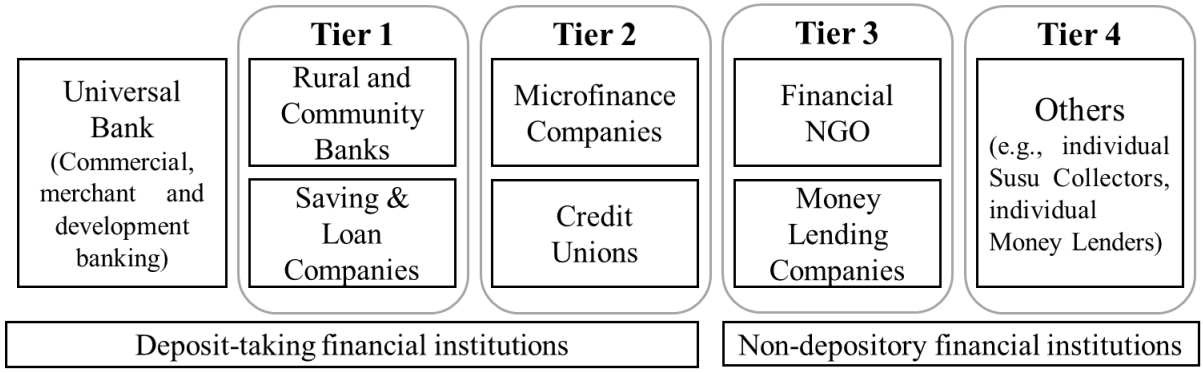

Figure 3-9 Structure of the financial sector in Ghana

Source: Prepared by the survey team based on World Bank (2016) Ghana's Microfinance Sector: Challenges, Risks and Recommendations. JICA (2020) Study on Innovative Financial Inclusion Approach in Agriculture and Health Sector, and interview of IFAD

In the agricultural sector, loans are mainly provided by the Agriculture Development Bank as well as by commercial banks, rural and community banks, and microfinance institutions[55]. The major financial institutions are listed in Table 3-10.

Table 3-10 Major financial institutions that provide loans in the agriculture sector and the number of such institutions

Institutions	Number
Commercial banks	23
Rural and community banks	145
Microfinance institutions [56]	137

Source: Survey team

However, for these financial institutions, providing loans to the agricultural sector is risky, particularly to small-scale farmers who do not have sufficient collateral or security. Nonetheless, in some cases, loans are provided to organizations and individuals that are well-funded, have a good track record, and are easy to track, such as farmer groups represented by cooperatives, water users' associations, and FBOs, as well as to large commercial farmers, agricultural service providers, and aggregators.

For instance, according to the water users association in the KIS, the AK/C1 area, where the interviews were conducted, an individual farmer belonging to the association could obtain the loan because the association acted as a guarantor on behalf of the individual. The association manages the repayment of loans of the individual farmer (Farmer A). If farmer A fails to repay the loan, the association restricts the use of farmer A's fields and assigns it to farmer B who can repay the loan. Farmer B is permitted to use farmer A's field to grow rice in exchange for farmer A's repayment. The water users' association also pays for the farmers' fertilizers[57].

[55] Alliance for Financial Inclusion (2018) Agricultural Finance Intervention in Ghana

[56] On May 31, 2019, the Bank of Ghana revoked the licenses of 347 microfinance institutions in accordance with the Specialized Deposit-Taking Institutions Act, 2016 (Act 930). As of April 2021, the number of microfinance institutions was 137 (from the Bank of Ghana website).

[57] Farmers repay water users association with their crops.

The lending rate of financial institutions is calculated by adding the interest rate of each financial institution to the Ghana Reference Rate (14.34% in March 2021) announced by the Bank of Ghana. For instance, the ADB applies an interest rate of 22–26% for loans to the agricultural sector, by adding 8–12% to the Ghana Reference Rate. The average interest rate for the rural and community banks is around 25% in Greater Accra, around 24% in Kumasi, and around 28% in rural areas, such as Eastern and Northern provinces. According to the Association of Rural Banks, interest rates are set higher in rural areas than in urban areas because there is less competition among financial institutions.

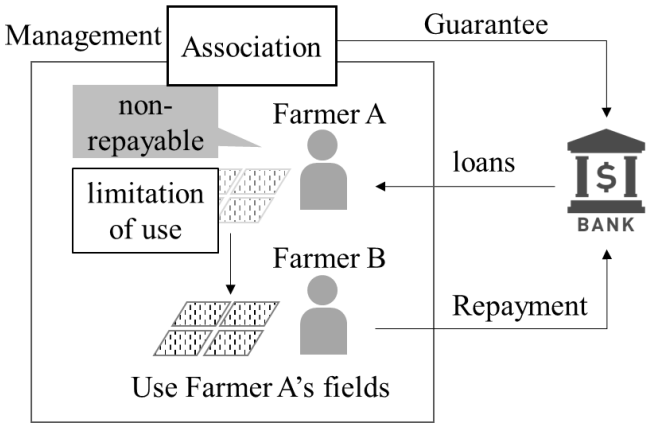

Figure 3-10 Example of how the KIS water users' association manages loan repayment

Source: Survey team

3.8.1. Agriculture Development Bank (ADB)

ADB was established in 1965 as the agricultural credit and cooperative bank with investment from the Bank of Ghana and was later registered as a universal bank in 2004. There are 94 branches in Ghana[58]. The Agribusiness Division of ADB, which deals with agricultural finance, constitutes two departments, namely Agricultural Value Chain and Agricultural Services Department. In 2020, the agribusiness sector accounted for 30% of the total portfolio[59], although the goal is to increase the share of this sector to 50% by 2022 as part of the five-year strategy[60].

However, ADB does not provide loans to individual farmers due to the high risk involved in lending to the agricultural sector, and loans are limited and provided to large commercial farmers, agricultural service providers, and aggregators. ADB provides two types of loans depending on the crop: short-term and long-term loans. In the rice sector, short-term loans of approximately six months are mainly provided as working capital required to purchase inputs, such as seeds and fertilizers. Most of the long-term loans are provided for cash crops, such as cocoa, shea, palm oil, and rubber. The loan amount is determined by the repayment capacity and credit of the loan recipient.

[58] Bank of Ghana website
[59] The agribusiness sector targets the agriculture, forestry, and fisheries industries. It covers food crops, fisheries, and forestry, and food crops include rice.
[60] ADB website (https://www.agricbank.com/news/adb-to-offer-more-support-to-agribusiness-entrepreneurs/)

3.8.2. Rural and community banks

In rural and community banks, different banks have different lending policies. For instance, Manyacrobo Rural Bank does not provide loans to rice farmers, even to a farmers' group, although they provide loans to cash crop (e.g., mango) producing farmers for the purchase of agricultural machinery. The reason for not providing loans to rice farmers is the low demand for domestic rice and the small size of the market. According to Manyacrobo Rural Bank, if the demand for locally produced rice increases in the future and the profitability of rice farmers increases, the bank would consider providing loans.

Okomfo Anokye Rural Bank is a participating financial institution (PFI) in the Rural Enterprise Programme (REP) of the International Fund for Agricultural Development (IFAD) and provides loans at low interest rates not only to farmer groups but also to individual farmers. Two funds, namely the Rural Enterprise Development Fund and the Matching Grant Fund, have been established under the REP to improve access to finance in the agricultural sector. Rural and community banks registered as PFIs[61] can raise loan resources from the REP fund at low interest rates and thus provide loans to farmers at low interest rates. Okomfo Anokye Rural Bank separately analyzes the risk of offering loan to each farmer and provides loans at the REP rate plus an interest rate corresponding to the risk, ranging from 11–14%. Loans are mainly short term, with a maximum loan amount of GHS 50,000 (995,950 yen) to rice farmers and GHS 200,000 (3,823,800 yen) to poultry farmers. The farmers use loans as working capital or for the purchase of irrigation pumps and pesticide sprayers. Loans are rarely provided for the purchase of expensive farm machinery, such as combine harvesters, although the bank is willing to consider financing the purchase of farm machinery if the farmer (or a farmers' group) has nearly 10–15 acres of farmland.

3.8.3. Commercial banks

Absa Bank and Eco Bank have partnered with a company that has developed an online platform to track the activities of each supply chain in the agricultural sector and offer small loans of USD 100–500 (11,020–55,500 yen) based on farmers' credit scoring data accumulated and analyzed by the platform. In addition, Eco Bank has set up a dedicated desk to facilitate agricultural financing across the entire value chain, from crop production to processing and marketing[62]. As in the case of Absa Bank and Eco Bank, if information and communication technology (ICT) is used to accumulate credit information on farmers, banks will be able to make credit decisions based on these data, rendering loan provision to individual farmers easy.

Among the 52 PFIs participating in the Financing Ghanaian Agriculture Project (FinGAP) of the United States Agency for International Development (USAID), commercial banks provided the largest amount[63] of loans to rice, maize, soybean, and corn producers, processors, aggregators, traders, and input providers. The value accounted for 75.4% of the total loan amount of USD 168 million (18.5 billion yen)[64]. According to USAID, through FinGAP, the share of financing for the agricultural sector in the PFI portfolio

[61] According to IFAD (2019) Republic of Ghana Country Strategic Opportunities Programme 2019-2024, 66 banks have partnered as PFIs for REP. Two commercial banks have registered as PFIs, and the rest are rural and community banks.

[62] B&FT Online (https://thebftonline.com/01/12/2020/ecobank-underscores-the-importance-of-agri-financing-at-10th-pre-harvest-event/)

[63] Commercial banks, financial NGOs, saving & loan companies, credit unions, local community banks, and microfinance institutions, among others. Commercial banks provide the largest amount of loans among PFIs participating in FinGAP.

[64] USAID FinGAP was implemented from 2013 to 2018; over a dozen commercial banks participated in FinGAP. USAID (2018) FINAL REPORT FINANCING GHANAIAN AGRICULTURE PROJECT (USAID FinGAP)

has increased from 6% to 13%[65]. Moreover, the project has facilitated access to finance for the agricultural sector. For instance, Absa Bank (formerly Barclays) provided approximately USD 60 million in loans over five years to processors and input suppliers[66].

Thus, commercial banks are actively promoting loans to the agricultural sector through the use of ICT and collaboration with donor projects.

3.8.4. Microfinance institutes

An example of a microfinance institute (MFI) is Success for People Microfinance, a participant in USAID FinGAP, which provided working capital loans to farmer groups for input purchases and other needs as well as warehouse security loans that use crops as collateral[67]. According to Agrocenta, however, many MFIs do not provide loans to farmers due to the lack of resources. Similarly, Ross Capital Microfinance does not provide loans to farmers because the bank only provides loans to salaried workers and farmers do not have a stable income[68].

3.9. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for establishment of AFICAT is proposed by the survey team.

3.9.1. Basic policy for the establishment of AFICAT (draft)

For the following reasons, AFICAT will be based in the KIS region, which was the base of the "Project for Enhancing Market-Based Agriculture by Smallholders and Private Sector Linkages in Kpong Irrigation Scheme (MASAPS-KIS Project)" implemented by JICA from January 2016 to July 2021:

- It is close to the capital city of Accra (100 km northeast, 2–3 hours by car).
- There is 2,032 ha of irrigated land (paddy fields) with 2,767 farmers involved, rendering demonstrations on a certain size of paddy fields easy.
- Some of the plots are relatively large (approximately 1 ha), rendering the introduction of agricultural machinery easy.
- The area is a base for JICA project activities, and local human resources, including GIDA staff, are being trained.
- The area is close to urban areas and labor wages are high; thus, mechanization is well underway.
- A track record of collaboration with research institutions is available.

In cooperation with the Ghana Rice Production Improvement Project (GRIP), which was scheduled to start in FY2021 by JICA, AFICAT will work closely with GRIP to ensure efficient implementation of exhibitions, verifications, demonstrations, and public relations.

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[65] Same as above

[66] USAID (2018) TRANSFORMING THE MARKET FOR AGRICULTURAL FINANCING IN GHANA: Lessons Learned from the Implementation of the Financing Ghanaian Agriculture Project (USAID FinGAP)

[67] JICA (2020) Study on Innovative Financial Inclusion Approach in Agriculture and Health Sector

[68] Ministry of Agriculture, Forestry and Fisheries (2020) Project for Promotion of Food Value Chain Development (African Countries) - Ghana: Survey on Stone Cutting Machines – Report, and JICA (2019) Preparatory study for the project on sales of agricultural machinery to small-scale farmers, Ghana (promotion of BOP business cooperation)

3.9.2. Candidate institutions/locations/schemes for collaboration with AFICAT (draft)

In the irrigated areas, AFICAT will start its activities in KIS areas, where vast irrigated fields have been developed and human resources have been trained, as mentioned above. The activities will be expanded to other irrigated areas according to the progress of GRIP and the security status.

Photograph 3-15 Irrigated paddy field in KIS (approx. 2,000 ha)

Photograph 3-16 Chinese combine harvester

Photograph 3-17 Rice mill in KIS

Source: Survey team

For rainfed areas, Upper East, Oti, Eastern, and Northwest regions are candidates for GRIP, while Ashanti, Northern, Savannah, and Northeast regions are sub-project sites. At present, verifications and demonstrations of power tillers and tractors can be planned here, which are expected to be in great demand in Ashanti region, where fields are small and mechanization is not yet advanced. A plan should be made after discussing with DCS whether and how AFICAT will be deployed in rainfed areas.

Photograph 3-18 GIDA's workshop and machine shed of the MASAPS-KIS project

Source: Survey team

3.9.3. Candidate institutions for collaboration with AFICAT

The following organizations are assumed to be candidate institutions for collaboration.

(1) KNUST

KNUST, located in Kumasi, Ashanti Region, has been requested by MoFA to establish a National Center for Agricultural Mechanization and Management. The university is well-equipped with human resources and facilities in the field of mechanical engineering and has 37 acres (15 ha) of plots (e.g., upland fields for maize) and workshop for agricultural machinery. They also conduct performance tests of agricultural machinery as part of curriculum.

According to interviews during this survey, they are strongly interested in collaborating with Japanese companies on new technologies. There is a possibility of collaboration in the following areas:

manufacturing and development of simple agricultural equipment, such as trailers, verification of agricultural equipment for upland field crops using field (performance testing of work capacity, accuracy, and durability) and laboratory functions.

(2) Adidome Farm Institute

It is located in Adidome, Central Tongu District, Volta Region, which is relatively close to Accra and KIS. It was established in 1964 as an agricultural training center under MoFA. It is well equipped for both greenhouse and open field cultivation. At present, the institute is mainly focused on secondary education, offering a one-year course in general agriculture. In addition, short-term courses are available. In collaboration with local agents of Japanese machinery manufacturers, the institute also offers training for operators by utilizing its resources, such as fields, farm machinery, and instructors. The irrigated plots are currently smaller than 3 acre (1.2 ha), but these can be expanded to around 2 ha upon improvement and can be used for training related to rice and horticultural crops.

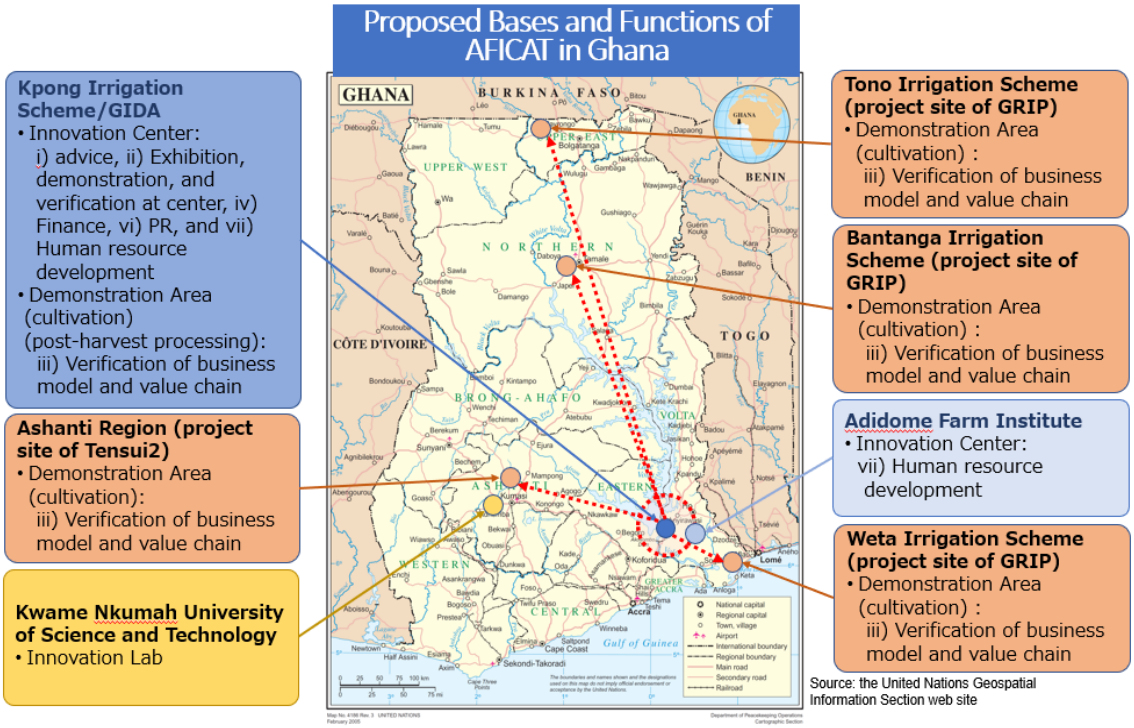


Figure 3-11 Candidate institutions, their locations, and their functions for AFICAT

(3) Other organizations

Collaboration with the following organizations can also be expected:

✓ Organizations related to agricultural materials
- CSIR-SRI: Lab function (fertilizer efficacy test, soil analysis)
- PPRSD-PFRD: Advice function (fertilizer registration)
- PPRSD-GSID: Lab function (seed quality analysis) and advice function (seed registration)
- EPA: Advice function (agrochemical registration)

✓ Organizations related to finance
- IFAD: Finance function (collaboration with GASIP Phase 2)

- PFIs of REP and GASIP: Finance function (financial access of rural farmers)
- Eco Bank and Absa Bank: Finance function (introduction of agriculture desk)

✓ Educational institutes
- University of Ghana: Assisted MASAPS-KIS project in preparing a rice cultivation manual, which is expected to have laboratory functions as the university uses 1 ha of test plot in KIS.
- Other agricultural universities: Under MoFA, there are agricultural educational institutes, such as the Damango Agric College, Ohawu Agric College, Ejura Agric College, and Wenchi Farm Institute. The Wenchi Farm Institute is for secondary education, but a collage course has recently been introduced. Similar to the Adidome Farm Institute, these institutes can potentially serve the human resource development and laboratory functions, although they will be given a low priority due to their distance from major cities.

✓ Research institutions
- CSIR-CRI: It has a department dedicated to the improvement of rice varieties, although it functions on a smaller scale in Ghana than in other rice-producing countries. Furthermore, there is a socioeconomics department, which focuses on efficiency through agricultural mechanization; however, there are no researchers specializing in agricultural mechanization, and there appears to be no farm machinery or fields to test the performance and efficiency of agriculture machinery. Although it is a candidate institution, it has low priority.

✓ JETRO Accra Office: Advice to Japanese companies on import/export-related matters and support for public relation activities for introducing Japanese technology to local companies[69].

3.9.4. Proposed seven functions of AFICAT

The institutions and locations mentioned above and which of the seven functions they can perform are listed below.

In GRIP, KIS is positioned as the center for the dissemination of agricultural technologies to other irrigated areas[70], and as mentioned above, AFICAT will establish an operational structure in KIS as a center for exhibition, verification, and demonstration and expand AFICAT activities to other irrigated areas covered by GRIP in line with the progress of GRIP. In particular, the northern part of the country has a high potential for rice productivity improvement, and Japanese companies are highly interested in this area; thus, provided that safety is ensured, a field survey will be conducted in the northern part of the country, which could not be visited during this survey period, to examine specific deployment methods in the next phase.

Among the seven new functions of AFICAT, the functions that could be implemented in KIS and their contents are as follows.

✓ Function 1: Advice
- Technical advice from Japanese experts to CPs and others
- Recommendations to the Ghanaian government through the verification of agricultural machinery and value chain

[69] According to JETRO, the establishment of a maintenance system after sales is important for Japanese companies related to agricultural machinery to enter Ghana.
[70] The information on rainfed land will be added when the intention of DCS on AFICAT is clarified.

- Provision of relevant information to Japanese companies

✓ Functions 2 and 3: Exhibition, verification, and demonstration
- Exhibition of agricultural machinery using GIDA workshops.
- Verification and demonstration of agricultural machinery using farmers' fields and demonstration plots (tractors, combine harvesters, various implement, power tillers, including small ones, sluice management systems, and sensing technology)
- Introduction of rice mill-related equipment in cooperation with local rice mills, domestic rice marketing companies (Sustainable Agro or Olam) to improve the quality of domestic rice and demonstrate domestic rice value chain (rice milling facilities, stone removal machines, moisture meters, and rice husk processing machines)

✓ Function 4: Finance
- Verification of the profitability of agricultural machinery and promotion of the launch of leasing and financing schemes for agricultural machinery in cooperation with local financial institutions
- Introduction of various financial schemes to Japanese manufacturers
- Promotion of agricultural machinery demonstrations in cooperation with local financial institutions

✓ Function 5: Innovation Lab
- Joint research and verification with educational institutions, such as KNUST and CRI, to promote the use of agricultural machinery

✓ Function 6: Public relations
- Implementation of public relations
- Sharing the results of verifications

✓ Function 7: Human resource development

The following personnel can be covered:
- GIDA workshop technicians and other mechanics in the area
- Farm machinery owners and operators in KIS
- Agricultural mechanics from other irrigation schemes in Ghana
- Officials from neighboring countries (in collaboration with JICA's training on Promotion of Agricultural Mechanization for Africa [PAMA] and third country trainings from other countries)

3.9.5. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

✓ Agricultural machinery
- Many of the major Japanese agricultural machinery manufacturers still do not have local agents or distributors, perhaps because they have not prioritized the SSA market. In such cases, it is necessary to start with the selection of distributors and dealers. Since many Japanese companies (44%) pointed out that they lacked information on agents and distributors, AFICAT is expected to provide information on potential agents and distributors as one of its functions.
- In rainfed lowlands, which account for 78.8% of the total rice cultivation area and 71.1% of the total paddy production, there has been little mechanization; however, in irrigated areas, land preparation using tractors and power tillers and harvest using combine harvesters have been mechanized.
- With support from the Brazilian and Czech governments, agricultural machinery manufactured in

the respective country is sold with subsidies. For agricultural machinery with similar functions, such as power tillers and tractors, Japanese companies are at a disadvantage in terms of price competition. Meanwhile, medium-sized combine harvesters for paddy harvest may offer more commercial opportunities than power tillers and tractors, because similar products are not available. Such information will also be provided to Japanese companies for their reference when they enter SSA.

As of March 2021, when the field survey was conducted, most combine harvesters were made in China and Japanese agricultural machinery was not available. Combine harvesters are cheaper than manual harvesting and threshing, and combine harvesters from other countries have proven highly efficient at the right time of harvest. The use of combine harvesters is expected to grow further in irrigated areas visited in this survey. In Tanzania, many farmers have replaced Chinese products with Japanese combine harvesters. According to Tanzanian government officials, Japanese combine harvesters are preferred because of high efficiency in threshing, low amount of foreign matter such as straw, almost no breakdown during operation, good performance even in wetlands with poor drainage, and high durability of various parts. Although the price of Japanese brands is higher than that of Chinese brands, given on the model, the products are considered worthy of the price. Similar outcomes are expected in Ghana. In this case, AFICAT will be able to support verifications and demonstrations as required.

Chapter 4. Current Status of and Issues Related to Agricultural Mechanization in Nigeria

4.1. Outline of the agriculture sector

4.1.1. Agriculture overall

In Nigeria, agriculture is a key industry accounting for 44.5% employment and 21.9% GDP and has supported Nigeria's economic growth by remaining strong even during the recent economic stagnation[71]. The country's total land area is 92.38 million ha, nearly 2.4 times the size of Japan, of which 69.12 million ha (75%) is agricultural land[72].

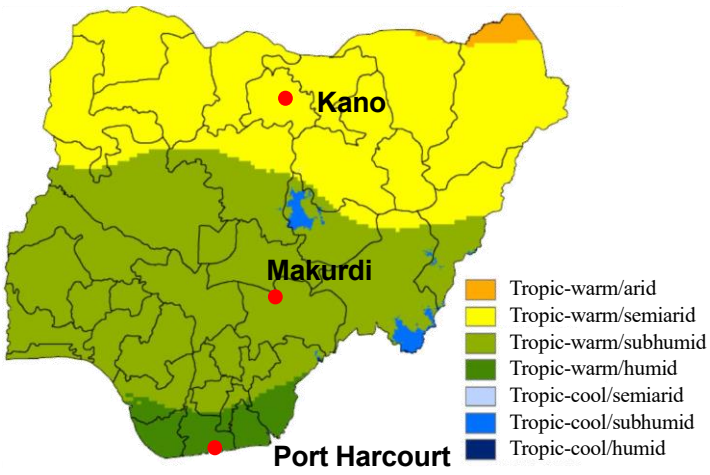


Figure 4-1 Agroecological zones in Nigeria

Source: WB (2014) Agriculture and Rural Poverty

As shown in Figure 4-1, the country's climate is divided into three major categories: steppe climate (tropical warm/semiarid) in the northern region, savanna climate (tropical warm/subhumid) in the central region, and tropical monsoon (tropical warm/humid) in the southern region facing the Atlantic Ocean.

Figure 4-2 shows the rainfall in Kano, the capital of Kano State; Makurdi, the capital of Benue State; and Port Harcourt, the capital of Rivers State (indicated as solid red circles in Figure 4-1).

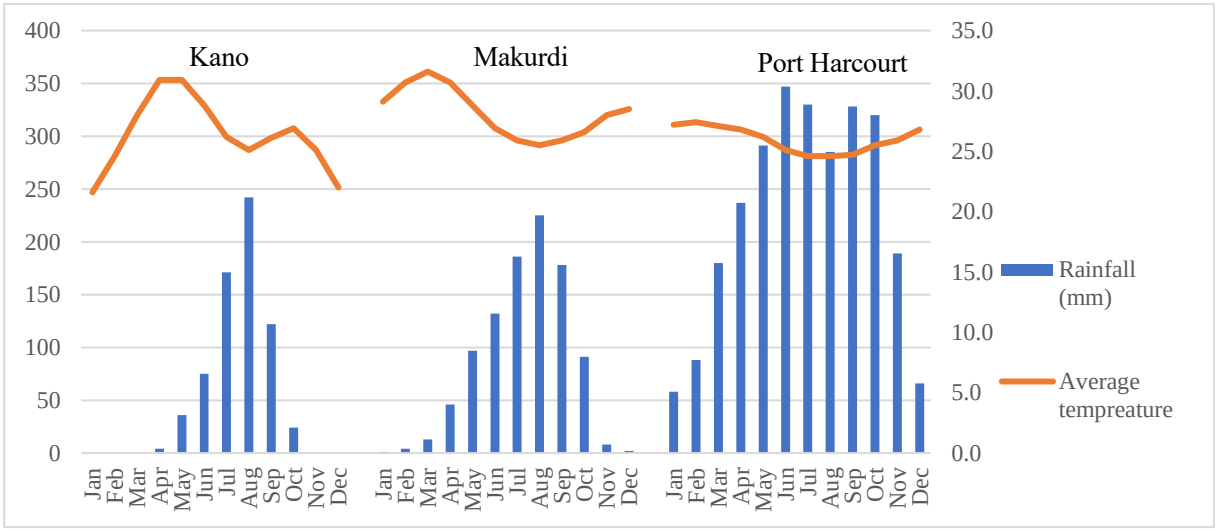


Figure 4-2 Rainfall in Kano, Makurdi, and Port Harcourt

Source: Prepared by the survey team based on data from climate-data.org

In 2019, cassava production was the highest in the country, at 59.19 million tons, followed by yam (50.05 million tons), maize (11 million tons), rice (paddy, 8.44 million tons), sorghum (6.67 million tons), and

[71] World Development Indicator (2019)
[72] FAOSTAT

groundnut (4.45 million tons) production. Nigeria is the world's largest producer of cassava and yam, 15th largest producer of maize, 14th largest producer of rice, 2nd largest producer of sorghum, and 3rd largest producer of groundnut. In addition, cocoa production is flourishing in the hot and humid regions with high rainfall in central and southern Nigeria[73]. According to the FAO, the country produces 350,000 tons of cocoa per year, ranking 4th in the world.

4.1.2. Rice production

As shown in Figure 4-3, domestic rice production increased from 2.37 million tons per year to 5.6 million tons (white rice equivalent) between 2009 and 2018, and Nigeria surpassed Madagascar to become the largest rice producer in SSA[74]. Rice consumption in the country has grown more rapidly than production due to recent population growth, urbanization, and changes in eating habits, with annual per capita consumption reaching 32.9 kg in 2018 from 22.8 kg in 2009[75]. In 2019, the country imported 845,000 tons of rice, which is only 13% of the total domestic rice consumption; however, due to the large domestic market, rice self-sufficiency is one of the main challenges for the Nigerian government in terms of ensuring food security and securing foreign currency.

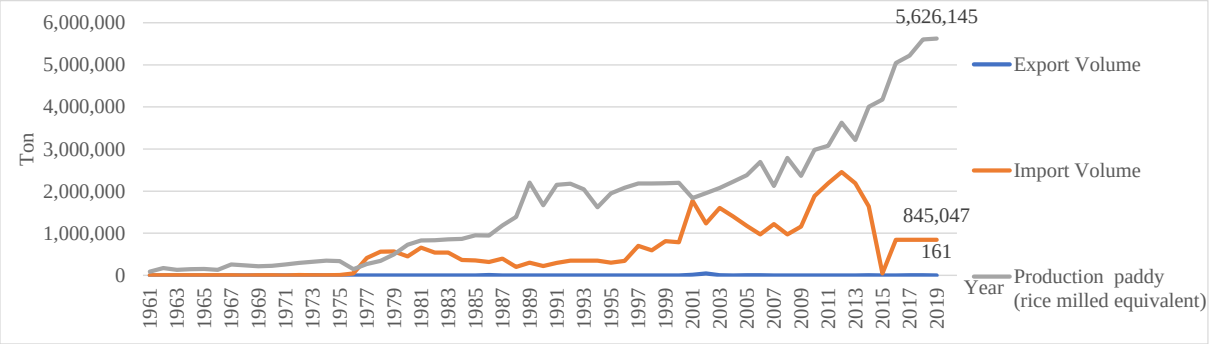


Figure 4-3 Trends of rice production, import, and export, in Nigeria

Source: FAOSTAT

Geopolitically, Nigeria is divided into six zones (geopolitical zones), namely North-West, North-East, North-Central, South-West, South-South, and South-East, as shown in Figure 4-4. Rice is produced in North-Central, South-West, South-South, and South-East geopolitical zones. Of these, rice production is concentrated in the North-Central region and some areas in the North-East and North-West regions.

Figure 4-5 shows the top ten states with the highest rice production among the 36 states and the Federal Capital Territory (FCT) in the country, and their respective paddy production volumes (in 1,000 tons)[76].

[73] According to NCAM, one of the challenges of rice production in such high rainfall areas is the need to use harvesting machinery in wet fields during the harvest season due to rainfall and poor drainage.
[74] FAOSTAT
[75] Calculated based on data of FAOSTAT and World Bank World Indicators
[76] Rice production in Jigawa, Kebbi, Kano, Sokoto, and Kaduna states decreased in 2020 because of flood.

Figure 4-4 Nigerian geopolitical zones

Source: National Population Commission (2018) Nigeria Demographic and Health Survey 2018

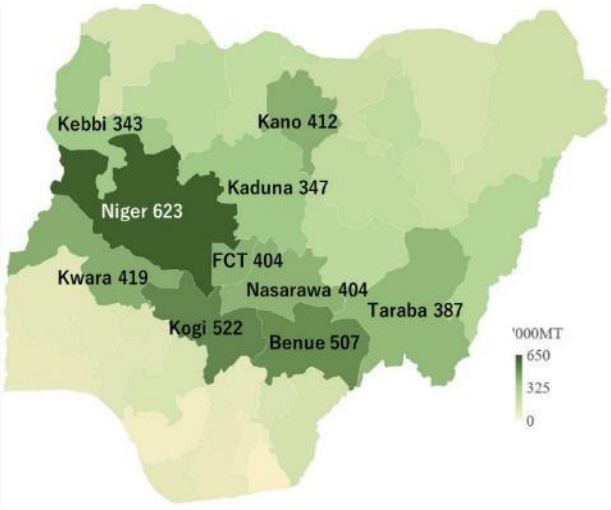


Figure 4-5 Major rice-producing regions and paddy production in Nigeria (in 1,000 tons) (2020)

Source: FMARD (2020) Agricultural Performance Survey in Nigeria 2020 wet season

As shown in Table 4-1, nearly half of the domestic rice production is from rainfed lowland areas, where rice is mainly grown during the rainy season. In many areas, paddy is cultivated only during the rainy season; however, in the North-Central and North-West regions, such as Kebbi, Kano, Jigawa, Taraba, Niger, Kaduna, Nasarawa, Sokoto, Zamfara, and Kogi, paddy is cultivated in both wet and dry seasons[77].

Table 4-1 Paddy cultivation area and production in Nigerian rice-growing regions (2018)

		Rainfed lowlands	Rainfed uplands	Irrigated lands	Others	Total
Cultivated area	ha	1,504,000	960,000	544,000	192,000	3,200,000
	%	47	30	17	6	100
Production	Ton	290,000	98,600	156,600	23,200	580,000
	%	50	17	27	4	100

Source: Prepared by the survey team based on KPMG (2019) Rice Industry Review

Private companies are also investing in rice production. For instance, Dangote Group has invested over USD1 billion in Jigawa State to set up a processing plant for processing paddy purchased from farmers through the out-grower programs[78]. Olam Nigeria has invested USD 111 million (12.2 billion yen) to grow rice on 10,000 ha in Nasarawa State and sell it under the brand names Mama's Pride and Mama's Choice[79]. In addition, Stallion Group has invested USD 70 million (7.7 billion yen) in 2019 to expand the processing capacity of its rice mills to 44,000 tons per year, the largest in the country[80].

[77] GEMS4 (2017) Mapping of Rice Production Clusters in Nigeria
[78] UKAID etc. (2020) Nigerian Rice Investment Opportunities
[79] UKAID etc. (2020) Nigerian Rice Investment Opportunities and Olam website (https://www.olamgroup.com/locations/africa/nigeria.html)
[80] Farmers Review Africa (https://www.farmersreviewafrica.com/nigerias-popular-farms-and-mills-ltd-invests-us-70m-to-boost-agricultural-production-in-the-country/)

4.2. Outline of the major stakeholders

4.2.1. Stakeholders related to Federal Ministry of Agriculture and Rural Development (FMARD)

(1) Federal Ministry of Agriculture and Rural Development

The mission of FMARD is to ensure food security in the crop, livestock, and fisheries sectors; promote employment and services in the agricultural sector; facilitate agricultural production and supply of raw materials to the agro-industries; and support foreign exchange and rural socioeconomic development.

Under the Minister of FMARD, each state has its own Minister of Agriculture. At the federal level, the Permanent Secretary is placed directly under the Minister, and the Director of each department is placed under the Permanent Secretary. In the Federal Department of Agriculture (FDA), the National Rice Desk Officer is a focal person of CARD and the Director (Engineering and Mechanization) in charge of agricultural mechanization. The Agribusiness Marketing Development Department (ABM) is in charge of projects on the post-harvest processing of crops, including rice, with the main mission of developing necessary infrastructure and establishing agricultural finance and insurance for agricultural investment to promote agricultural value chains and industrialization. The Extension Service Department is in charge of agricultural extension activities, and the Farm Inputs Support Services Department is in charge of fertilizer registration.

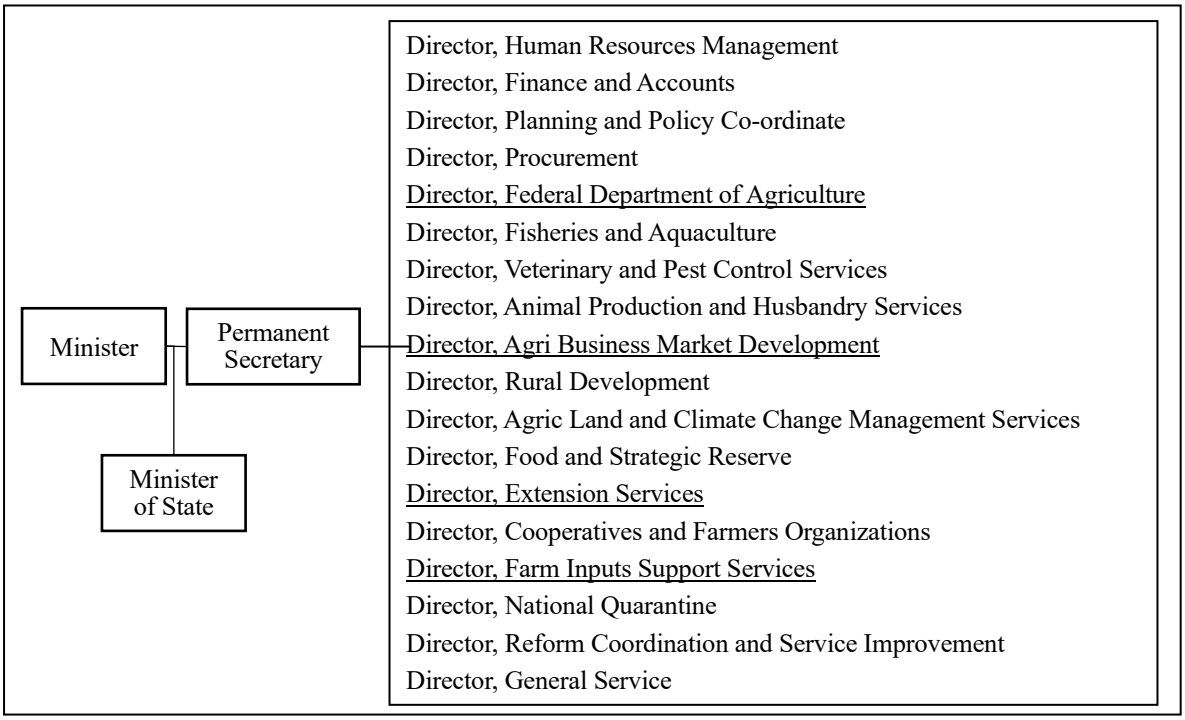


Figure 4-6 Organogram of FMARD

Source: Prepared by the survey team based on materials provided by the JICA advisor for agriculture development

(2) Agricultural Mechanics and Machinery Operators Training Center (AMMOTRAC)

AMMOTRAC, an organization under FMARD, is responsible for capacity building of mechanics and operators of agricultural machinery in the country. There are two AMMOTRAC centers, one in Misau, Bauchi state, and the other in Akure, Ondo state. The former center covers 19 northern states and the latter center covers 17 southern states. However, the Misau center was not functional as of May 2021 due to security

issues[81]. At the Akure center, 35 university students were trained in 2020. As of June 2021, Japanese experts were not allowed to visit both centers because of JICA security restriction.

(3) National Center for Agricultural Mechanization (NCAM)

NCAM is an independent organization under FMARD to promote agricultural mechanization. Its main roles are to conduct research on the development of domestic machinery for agricultural work and processing; to develop designs for easy-to-use and low-cost machinery that can be manufactured domestically; to standardize and certify agricultural machinery in collaboration with the Standards Organization of Nigeria (SON); to aid the commercialization of proven agricultural machinery; to develop methods and tools for promoting mechanization; to provide information on methods and programs; to develop human resources through training and seminars for proper mechanization; and to collaborate with other national and international organizations.

The headquarters is located in Ilorin, Kwara State, and new zonal offices have been established in Akure, Ondo State; Samaru, Kaduna State; and Umudike, Abia State. There are 257 staff members, of which 154 are technicians (engineers and scientists, among others) and the rest are non-technicians. As of June 2021, the Japanese experts were not able to visit the institute because of JICA security restriction; however, it is important as a major institution responsible for agricultural mechanization, and the possibility of collaboration will be continuously considered.

(4) National Cereal Research Institute (NCRI)

NCRI is one of the 15 agricultural research institutes under FMARD, and its research focus is limited to cereals, such as rice, legumes, and sugarcane. The headquarters was located in the marshlands of Ibadan, Oyo State, until December 1984, and it was subsequently moved to the present location in Badeggi, Niger State. In addition to the headquarters, there are other stations in Ibadan, Oyo State; Warri, Delta State; Amakama-Olokoro, Abia State; Uyo, Akwa-Ibom State; Bacita, Kwara State; Mokwa, Niger State; Birnin-Kebbi, Kebbi State; Numan, Adamawa State; Yandev, Benue State; and Riyom, Plateau State.

There are 300 staff members, including over 200 scientists. For rice, they conduct adaptation trials for seed variety registration, rice breeding, BS maintenance and multiplication, and FS/CS multiplication. Adaptation trials of seeds are conducted at several stations to ensure that the seeds can be grown in different parts of the country. The NCRI headquarters has 52 ha of irrigated paddy field used for rice cultivation.

[81] From interview with a local consultant hired by the survey team

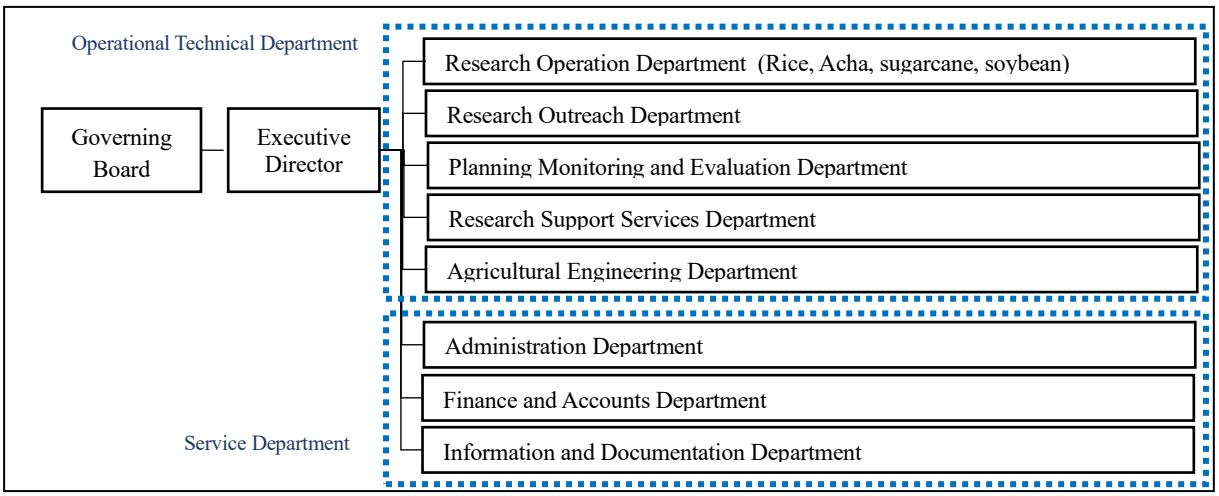


Figure 4-7 Organogram of NCRI

Source: Prepared by the survey team based on materials provided by NCRI and their website

(5) National Agricultural Extension and Research Liaison Services (NAERLS)

NAERLS is one of the 15 agricultural research institutes under FMARD, and its main focus is agricultural extension, including the development and evaluation of agricultural technologies, extension, research on extension technologies and policies, and capacity building of relevant stakeholders. The headquarters is in the premises of Ahmadu Bello University, Zaria, Kaduna State. There are 533 staff members, with zone offices in each of the six geopolitical zones[82]. NAERLS has eight divisions, one of which is the Agricultural Engineering and Irrigation Division with over 30 staff members.

As extension staff, 30,000 youths were employed by various local governments in Nigeria. NAERLS was in charge of developing materials and conducting training for the master trainers of newly hired extension staff.

4.2.2. Nasarawa State Government

In Nigeria, the state governments have their own budget and development projects at the state government level. Nasarawa State is adjacent to FCT, which is located in the capital city Abuja. In 2020, crop production in Nasarawa State in 2020 was as follows: 3,829,540 tons of yam, 1,722,270 tons of cassava, 308,080 tons of maize, 403,950 tons of rice, 210,180 tons of groundnut, and 161,550 tons of sorghum[83]. Agricultural extension is administered by the Nasarawa Agricultural Development Program (NADP), which is responsible for agricultural extension under the department of agriculture of the state.

4.2.3. Federal Ministry of Water Resources (FMWR) and related government organizations

(1) Federal Ministry of Water Resource

FMWR is responsible for the conservation, development, and management of various water uses with the objective of contributing to the socioeconomic activities of the country through comprehensive

[82] Specifically, there are zonal offices in Badeggi, Niger State (in NCRI premises); Maiduguri, Borno State; Kano, Kano State; Umudike, Abia State; Port Harcourt, Rivers State; and Ibadan, Oyo State (in NCRI outstation).
[83] FMARD (2020) Agricultural Performance Survey in Nigeria 2020 Wet Season

planning, conservation of freshwater ecosystems, adequate access to safe water and sanitation, production of adequate food, and provision of employment opportunities. In addition to the departments in charge of dams and reservoirs and those in charge of irrigation and drainage, there are also departments in charge of water quality and sanitation management. There are 12 River Basin Development Authorities (RBDAs), which are responsible for the development and operation of river basins in the country, and FMWR is in charge of supervising them.

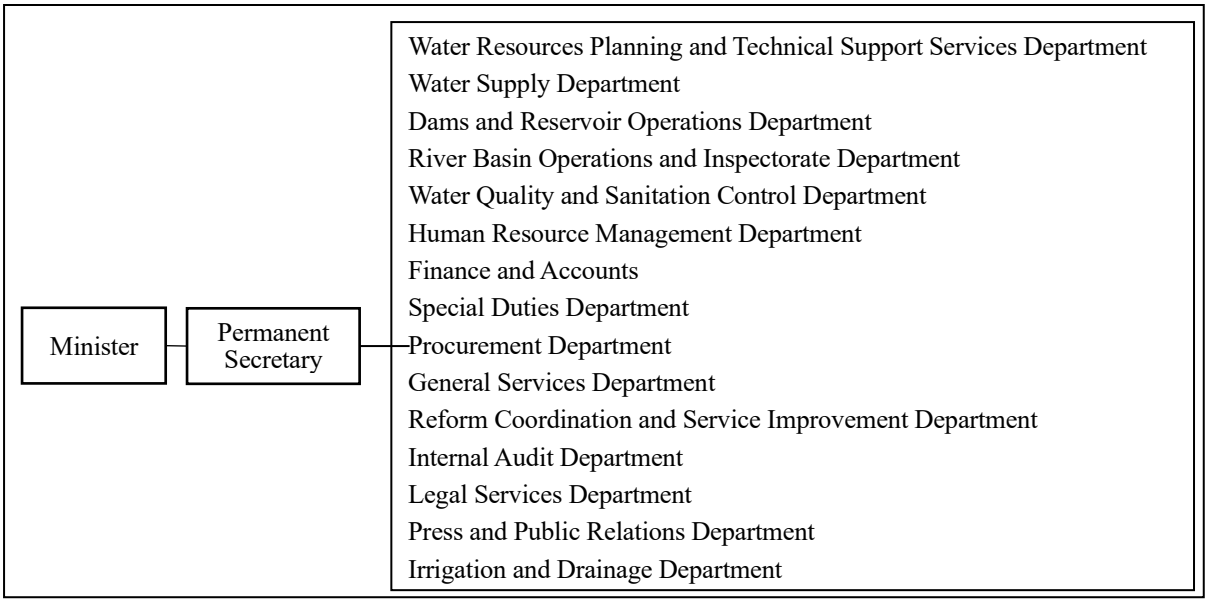


Figure 4-8 Organogram of FMWR

Source: Prepared by the survey team based on website of FMWR

(2) River Basin Development Authority

RBDA is an agency under FMWR responsible for the construction and management of dams as well as irrigation and water supply facilities. There are 12 RBDAs in Nigeria, which are responsible for the comprehensive development of surface and ground water resources in their respective basins, with particular emphasis on the provision of irrigation infrastructure, flood and erosion control, and basin management[84]. The National Water Resources Master Plan (2013) was prepared with the support of JICA, under which the entire country was divided into eight hydrological regions. The locations of these eight hydrological regions and the 12 RBDAs are shown in Figure 4-9.

[84] FMWR (2016) National Water Resources Policy 2016

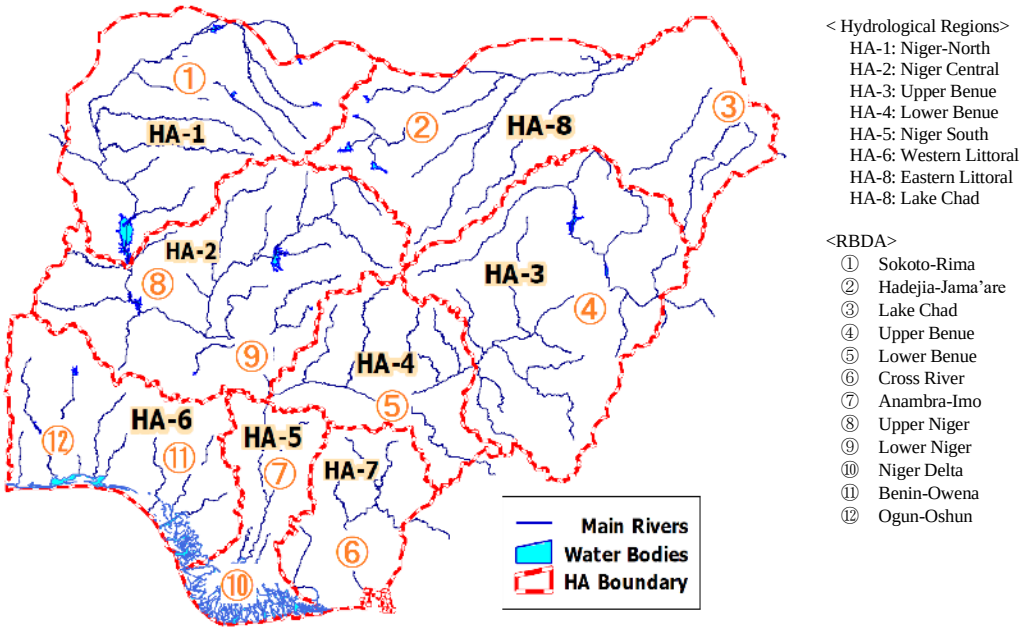


Figure 4-9 Hydrological regions and RBDAs in Nigeria

Source: Prepared by the survey team based on JICA (2014) The Project for Review and Update of Nigeria National Water Resources Master Plan and FAO website[85]

The area of the existing irrigation projects and new irrigation projects planned in the master plan in each hydrological region are summarized in Table 4-2. Among these, irrigation improvement is underway in HA-1, HA-3 and HA-8 from 2014 to 2022 under a World Bank project (Transforming Irrigation Management in Nigeria: TRIMING).

Table 4-2 Irrigation projects under the National Water Resources Master Plan 2013 (ha)

	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Existing irrigation scheme	41,041	26,946	20,265	12,494	17,700	29,398	8,410	84,598	240,852
1) Completion with no extension	24,441	3,048	905	877	630	1,449	2,250	4,418	38,018
2) Ongoing	9,750	5,200	11,110	1,100	11,490	24,617	1,000	34,630	98,897
3) Extension	6,850	18,698	8,250	10,517	5,580	3,332	5,160	45,550	103,937
New irrigation scheme	1,500	7,400	111,700	48,000	23,100	1,500	34,700	0	227,900
1) Supplementary irrigation	0	0	0	0	19,000	0	29,000	0	48,000
2) Dam irrigation	1,500	7,400	39,200	21,500	4,100	1,500	5,700	0	80,900
3) Integrated development	0	0	72,500	26,00	0	0	0	0	99,000
Total	42,541	34,346	131,965	60,494	40,800	30,898	43,110	84,598	468,752

Note: Hydrological regions targeted by the World Bank project, TRIMING, are highlighted
Source: JICA (2014) The Project for Review and Update of Nigeria National Water Resources Master Plan

Under TRIMING, irrigation development is underway in Bakolori Irrigation Scheme, Middle Rima Valley Irrigation Scheme (both HA-1), Dadin Kowa Irrigation Scheme (HA-3), Kano River Irrigation Scheme, and Hadejia Valley Irrigation Scheme (both HA-8)[86]. The outline of each irrigation scheme is as follows:

[85] FAO website (http://www.fao.org/fishery/docs/CDrom/aquaculture/a0844t/docrep/008/AD793B/AD793B01.htm)
[86] WB (2014) Transforming Irrigation Management in Nigeria Project - Appraisal Document

Table 4-3 Target area of the World Bank project, Triming

Hydrological area		Irrigation Scheme	Outline
1	HA-1 Niger-North	Bakolori Irrigation Scheme	The Bakolori Dam, which became operational in 1983, has a storage capacity of 450 million cubic meters and a lake area of 8,000 ha, with a hydroelectric power generation capacity of 3 MW. The project office is located in Talata Mafara, Zamfara State. Originally, area of 23,000 ha (8,000 ha for surface irrigation and 15,000 ha for sprinkler irrigation) was planned to be irrigated. Under the World Bank project, 13,000 ha are being developed.
2		Middle Rima Valley Irrigation Scheme	Located in Goronyo, Sokoto State, Goronyo Dam is under the jurisdiction of the Sokoto-Rima RBDA and is a multipurpose dam designed to store 942 million cubic meters of water and irrigate 5,000 ha of land. There are plans to double the rice production area from 40,000 ha to 80,000 ha.
3	HA-3 Upper Benue	Dadin Kowa Irrigation Scheme	This is an irrigation scheme under the jurisdiction of Upper Benue RBDA. It is located in Dadin Kowa, Gombe State. The source of water is Dadin Kowa dam, built in 1989.
4	HA-8 Lake Chad	Kano River Irrigation Scheme	The Kano River Irrigation Scheme is one of the largest and most successful irrigation schemes in Nigeria. It is located in Bunkure, Kura, and Gram Malam in Kano State. The project office is located in Kura. The total irrigable area is 22,000 ha.
5		Hadeja Valley Irrigation Scheme	Hadeja Jama'are an irrigation scheme under the jurisdiction of RBDA and is located in Hadeja, Jigawa State. The potential irrigable area is 25,000 ha. The main canal in the north, which is already completed and in use, is 27 km long and covers the areas of 12,500 ha plus 5,300 ha.

Source: Prepared by the survey team based on website of Triming (https://www.triming.org/)

4.2.4. Others

(1) Various industry groups and associations

There are industry associations for rice and agricultural machinery in Nigeria. The survey team will collaborate with these industry organizations when necessary.

Table 4-4 Industry associations related to rice and agricultural machinery

Name		Outline
1	Rice Farmers Association of Nigeria (RIFAN)	It has 1.2 million farmers as members. In addition to the National President, there is a Vice President for each of the six geopolitical zones, a Chairman and a Vice Chairman for each state, and local government and ward levels below them.
2	Paddy Dealers Association of Nigeria	There is an organization in each state, with over 3,000 registered members. The Grain Aggregating Center was introduced by PPP in collaboration with FMARD.
3	Rice Processors Association of Nigeria (RIPAN)	The members are large-scale auto rice mills with a capacity of 10,000 tons per year (2 tons per hour). It has about 50 members.
4	Rice Millers Association of Nigeria (RIMAN)	The membership includes small- and medium-sized rice millers, with nearly 350 registered members, some of whom own fully or semi-automatic rice milling lines. Most of the members have rice milling equipment with a capacity of 20 tons per day (2.5 tons per hour), while a few members have equipment with a capacity of 50 tons per day (6 tons per hour).
5	Lafia Rice Millers and Dealers Association	The members include rice millers, paddy/rice dealers, and parboilers at the rice milling cluster in Lafia, Nasarawa State. There are 750 members, who own nearly 352 small Engelberg-type rice mills.
6	Nigeria Institution of Agricultural Engineers (NIAE)	There are approximately 3,000–3,500 members, excluding students. With nearly 100 engineers, NIAE has a secretariat within NCAM.
7	Tractor Owners and	This is an agricultural machinery service provider based in Zaria, Kaduna State.

Name		Outline
	Hiring Facilities Association of Nigeria (TOHFAN)	Its business model is to connect tractor owners with hiring service providers, among others, and it provides services in all 36 states of Nigeria.

(2) Nigerian Agricultural Mechanization and Equipment Leasing Company (NAMEL)

NAMEL is a private company engaged in the business of leasing agricultural machinery. The company has tried starting various leasing projects, including leasing schemes for small-holder farmers (Agro-Machineries to Small-holder Farmers: Las-F), but has not yet been able to raise the necessary funds to start them.

Recently the Delta State Government and the Central Bank of Nigeria have provided funds to develop 1,500 ha of farmland for cassava in Masogor, Delta State. NAMEL provides agricultural machinery services, although their leasing business is limited to their own operations.

They can develop a leasing scheme for agricultural machinery given that the main leasing company or other companies provide the necessary resources. In addition to agricultural machinery, they require heavy machinery for land development.

4.3. Related policies, strategies, and development plans

From 2010 to 2011, the Nigerian government formulated the Agriculture Transformation Agenda (ATA) to initiate reforms in the agricultural sector, which were subsequently implemented from 2011 to 2015. Some outcomes were achieved, although not all targets were met, and the country still relied on imports for major foodstuffs. To solve these problems, the Agricultural Promotion Policy and similar plans were formulated, as described below.

4.3.1. Agricultural Promotion Policy 2016-2020

The Agricultural Promotion Policy was formulated in response to two key issues: (i) domestic production does not meet domestic food demand and much of the country's food is imported; and (ii) Nigeria has not been able to export agricultural products of the quality demanded by international markets and has not been able to earn as much foreign currency as expected. Rice, wheat, maize, fish, dairy products, soybean, poultry, horticultural crops (fruits and vegetables), and sugar are produced for domestic demand, while cowpeas, cocoa, cashew nuts, cassava (starch, chips, and ethanol), ginger, sesame, oil palm, yams, horticultural crops (fruits and vegetables), beef, and cotton are exported overseas as priority crops.

In collaboration with a wide range of private stakeholders, from farmer groups to private companies, the policy aims to promote the development of the entire value chain by improving the supply of fertilizers and pesticides and promoting the use of high-yield seeds. In terms of mechanization, over 100,000 to 120,000 new tractors will be required in the next 5 to 8 years. The policy aims to promote mechanization services led by the private sector, boost the domestic production of agricultural machinery, enhance import of agricultural machinery that cannot be produced locally, and standardize agricultural technology.

4.3.2. National Rice Development Strategy

NRDS was formulated in 2009 and the NRDS Phase 2 (NRDS2) in 2020. The goal of NRDS was to increase paddy production from 3.4 million tons in 2007 to 12.85 million tons by 2018. To achieve this goal, NRDS planned to improve the extension system, establish modern rice processing facilities, rehabilitate old irrigation schemes, mechanize rice production and processing through public–private partnerships, and compensate the minimum price of rice[87]. In 2019, rice production doubled from the value in 2008, reaching 8.44 million tons, although only 66% of the target was achieved[88].

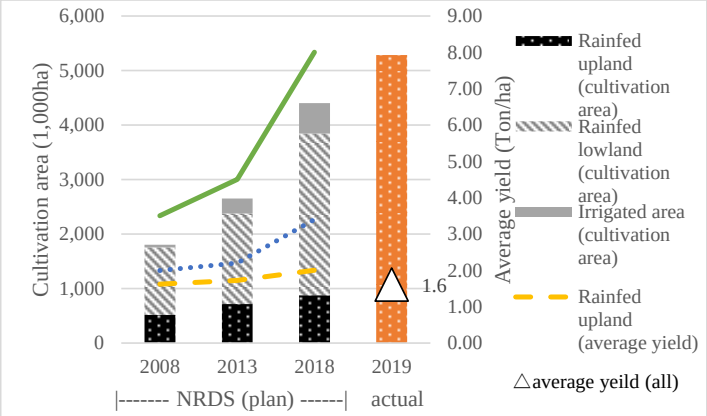


Figure 4-10 Planned and actual area and yield of NRDS (2009)

Note: The left axis shows cultivation area, and the right axis shows yield. The three bars on the left show planned values, and those on the far right show actual values.
Source: NRDS (2009) and FAOSTAT

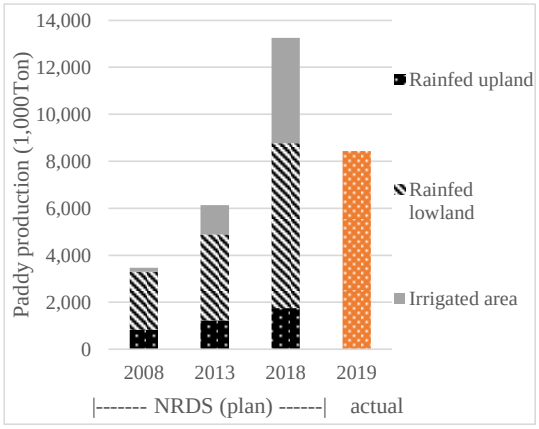


Figure 4-11 Planned and actual paddy production of NRDS (2009)

Note: The three bars on the left show planned values, and those on the far right show actual values.
Source: (Same as the left)

NRDS2, which outlines the strategy for 2020–2030, aims for improving the entire rice value chain to increase domestic paddy production and achieve full import substitution to meet domestic rice demand, which is estimated to increase at an annual rate of 5–10% as well as to ensure that there is a surplus for exports. The priority areas are (i) sustainable paddy production and increased storage; (ii) sustainable production of improved varieties and improved access to high quality seed; (iii) increased mechanization and utilization in rice production and processing; (iv) improved processing and marketing of locally produced rice; (v) improved access to financial services, including access to credit; and (vi) strengthened rice desks. Table 4-5 summarizes the baseline and 2030 targets for the main objectives of NRDS2.

Table 4-5 Targets of NRSD2

		Unit	Baseline	Target		
				2020	2025	2030
1	Paddy production	Million ton	11.00	13.20	21.20	25.0
2	New development in rainfed lowlands	Million ha	0.45	0.55	1.50	2.50
3	Yield in rainfed uplands	ton/ha	2.00	3.00	3.50	4.00
4	Yield in rainfed lowlands	ton/ha	3.00	3.50	4.00	5.00
5	Yield in irrigated lands	ton/ha	4.00	4.50	5.00	7.00

Source: NRSD2

[87] NRDS
[88] FAOSTAT

(1) Green Imperative Project[89]

The More Food International Programme[90], an initiative of the Brazilian government, was named the Green Imperative Project in Nigeria and its implementation was announced by Nigeria's Vice President, Mr. Yemi Osibanjo, in January 2019. The Brazilian government will provide USD 1.2 billion (131.8 billion yen) in funding from the Deutsche Bank and the Brazilian Development Bank to the Nigerian government to fund the project, which aims to strengthen agricultural mechanization, extension services, and agro-processing.

For agricultural mechanization, 10,000 tractors, 50,000 harvesters, and various other machines will be provided, and the machines will be assembled at six plants in Nigeria to create jobs and develop human resources. The machines were supposed to be imported in the first quarter of 2021, although as of June 2021, they had not been imported yet, and the Nigerian government aimed to import these by the end of 2021.

The machines introduced in the project will be provided to private companies that operate "service centers." Private vendors will be able to receive loans at low interest rates if they pay 20% of the purchase cost of the farm machinery as down payment. The moratorium period is 3 years, and the loan period is 10 years, which are relatively good conditions.

(2) State government subsidies for agricultural machinery

In addition to the federal government's actions, state governments can purchase some agricultural machines from their own budgets and sell them at subsidized rates. For instance, the Jigawa state government sold a tractor (with attachments) with a market price of NGN 11 million (2.95 million yen) for NGN 6.8 million (1.82 million yen) in 2019. The Jigawa state government was also planning the sale of a tractor (with attachments) with a market price of NGN 15 million (4.02 million yen) for NGN 9.7 million (2.6 million yen) in 2021. If a purchaser pays 25% up front and 5% of the sales price as operating expenses, they can pay the rest in installments without interest. Under this scheme, the Jigawa government is working to introduce 150 tractors in 2021.

(3) Anchor Borrowers' Programme (ABP)

ABP was initiated by the Central Bank of Nigeria (CBN) in November 2015 as an initiative of President Muhammadu Buhari. It aims to improve the value chain by bringing together processing companies (anchor companies), small-scale farmers, input suppliers, and financial institutions of key agricultural commodities. Specifically, the program provides small-scale farmers with agricultural inputs, such as fertilizers, in kind or cash to increase crop production, stabilize supply to agro-processors, and eliminate the country's food balance deficit. Primarily through groups, farmers can either receive low-interest loans (up to 9% per annum) from the PFIs or receive the necessary inputs (in kind) from local suppliers (farmers who receive inputs in kind will have the cost of the inputs deducted when they sell their crops to anchor companies). Details are explained in section 4.8.

[89] FAO F-SAMA Webinar held on March 30, 2021, and interview with FMARD Federal Department of Agriculture Director (Engineering and Mechanization)

[90] The More Food International Programme has been implemented in Ghana, Senegal, Mozambique, and Zimbabwe.

4.4. Donor support

4.4.1. Supports from the Japanese Government including JICA

(1) JICA projects implemented in recent years

In the agricultural sector, a JICA technical cooperation project on post-harvest processing of rice was implemented from September 2011 to April 2016, as shown in Table 4-6. As of May 2021, the Project on Promotion of Market-oriented Agricultural Extension System for Livelihood Improvement in Nigeria (Nigeria SHEP project) was implemented, and an agricultural development advisor was dispatched to FMARD.

Table 4-6 Recent JICA projects related to agriculture implemented in Nigeria

Project name	Period	Implementing organization	Outline
Rice Post-Harvest and Marketing Pilot Project in Nasarawa and Niger States	September 2011 to April 2016	Department of Agribusiness Marketing, FMARD	With the project goal of improving the quality of locally produced rice, activities were undertaken to develop and improve the quality standards for locally produced rice; strengthen the capacity of state government officials to conduct training in marketing and management skills and post-harvest processing; and strengthen the post-harvest processing, marketing, and management skills of small-scale rice millers, parboil processors, rice farmers, and distributors. The project areas include Nasarawa and Niger States.
Project on Capacity Development for Nutrition Improvement in Federal Capital Territory	February 2019 to February 2024	Federal Capital Territory Administration (FCTA)	The project goals are to develop an effective approach for improving nutrition through food and to build a multi-sectoral system for implementing the approach. The project aims to develop an activity manual for improving nutrition and operational guidelines for the nutrition improvement approach and to strengthen the capacity of staff at the Federal Capital Territory Administration.
the Project on Promotion of Market-oriented Agricultural Extension System for Livelihood Improvement in Nigeria	From 2020	FMARD	With the project goal of improving the quality of extension activities for improving farmers' livelihoods, the project is strengthening the capacity of FMARD staff and extension officers in each state as well as customizing and disseminating extension development tools for nutrition improvement in collaboration with JICA's Project on Capacity Development for Nutrition Improvement in Federal Capital Territory. Twenty target states have been selected based on their horticultural potential and the number of extension workers.
Agriculture Policy Advisor	July 2018 to October 2019, December 2019 to January 2021	FMARD	With FMARD as CP, the project compiles and analyzes information on the agricultural sector in Nigeria, advises FMARD on the promotion of policies related to the sector, and supports concrete promotion of Japan's projects and initiatives (CARD, SHEP, and IFNA) in this sector.
Agriculture Development Advisor	February 2021 to January 2023	FMARD	With FMARD as CP, the project supports the promotion of agricultural sector development and nutrition improvement through food by conducting activities related to the promotion of the SHEP approach, NRDS2 implementation, nutrition improvement activities, agricultural sector development by the private sector, and rural finance.

(2) Planned JICA projects

There are plans to implement a CARD grant assistance project and a related technical cooperation project for rice seeds.

Table 4-7 Planned JICA project related to agriculture in Nigeria

Project name	Period	Outline
Technical cooperation project related to rice seeds	After 2022	A project for rice seed-related technical cooperation is under consideration.

(3) Grant Aid for the Increase of Food Production/Grant Assistance for Underprivileged Farmers (2KR)

Since 2000, grant aid for increase of food production (2KR) has been provided to Nigeria in FY2000, FY2001, and FY2002. In FY2002, only fertilizers were provided, while in FY2000 and FY2001, the following agricultural machinery was provided in addition to fertilizers:

Table 4-8 Machinery introduced in Nigeria through 2KR in FY2000 and FY2001

FY2000

	Products	Unit
1	Irrigation pump (gasoline), 2 inches	69
2	Human-powered sprayer (back-borne type) (14–16 L)	500
3	Hulling and milling machine with pre-cleaner[91] (>650 kg/h)	49
4	Tractor (2 WD) 55–65 hp	4
5	Disc harrow	4
6	Disc plough	4
7	Trailer	4

FY2001

	Products	Unit
1	Irrigation pump (diesel), 2 inches	100
2	Human-powered sprayer (back-borne type) (14–16 L)	1,000
3	Hulling and milling machine (650 kg/h)	100
4	Destoner (1 ton/h)	150
5	ULV power dispersion Machine	100

Source: JICA (2000) report on grant aid for increase of food production in Nigeria; JICA (2001) report on grant aid for increase of food production in Nigeria; and JICA and Ministry of Foreign Affairs websites

4.4.2. Supports from other donors

Donor projects related to rice production and agricultural machinery are summarized in Table 4-9.

Table 4-9 Other donors' projects in Nigeria

Project name/donor	Period	Outline
Value Chain Development Programme/IFAD	2012 to 2022	The project targets sustainable improvement of income and food security of poor rural households engaged in the production, processing, and marketing of cassava and rice in Anambra, Benue, Ebonyi, Niger, Ogun, and Taraba states and aims to develop agricultural markets and increase the productivity of small-scale farmers. The total project budget is USD 329.42 million (36.2 billion yen).
Transforming Irrigation Management in Nigeria/WB	2014 to April 2022	The project focuses on the development of targeted irrigation schemes (50,000 ha/140,000 farmers) and strengthening of water resource management and agricultural services in Northern Nigeria. One of the outcomes includes the improvement of agricultural productivity and strengthening of the value chain. The total project budget is USD 560.3 million (61.5 billion yen).
Green Imperative Project	From 2019	The Brazilian government raised USD 1.2 billion (131.8 billion yen) from Deutsche Bank and Brazilian Development Bank and provided project funds to the Nigerian government. Under this project, 10,000 tractors and 50,000 other agricultural machines will be provided.

Source: Prepared by the survey team based on website of the World Bank and FAO and material obtained during the survey in Nigeria.

[91] Pre-cleaner is a rough separator (oscillating sieve). It is a machine that removes foreign substances such as straw, sand smaller than rice, and large stones before hulling. It however cannot remove stones that are the same as rice grains.

4.5. Overview of agricultural mechanization

4.5.1. Current status of mechanization

Tractors, disk plows, disk harrows, and ridgers are the main agricultural machinery used in Nigeria. All of these are mainly used for land preparation for upland crops as well as for rice production in rainfed upland crops (upland rice) or plowing and harrowing in dry irrigated land conditions. In irrigated lands under dry conditions, irrigation after plowing and harrowing, followed by puddling and leveling works, are performed either manually or using animal power. However, in irrigated lands where a rotary plow (with tractors) can be used, irrigation after plowing with a disk plow, followed by puddling and leveling works, can be completed with a rotary[92]. The estimated use of tractors in Nigeria is less than 10%[93]. There are different methods of calculating the mechanization rate, including the use of tractors; the estimated rates are[94] 62%, 30%, and 8% for manpower, animal power, and machinery, respectively[95].

According to officials from FMARD and TOHFAN and a contractor of mechanical works as a service provider described later, nearly 100,000 tractors and work equipment are required to work at the right time based on the current farmland area; however, only around 7,000 tractors are currently in operation. Delays in work due to the lack of farm machinery decrease productivity and lead to grain losses. Although, for many small-scale farmers who are employed by large farmers, contract farming using manual or animal power is a very important source of income[96].

Photograph 4-1 Plowing with a disc plow (left) and harrowing with a disc harrow (right)
Source: Provided by NCAM

The staff member in charge of agricultural machinery at FMARD explained that the use of tractors contributes to the development of agriculture in Nigeria; therefore, tractorization is being promoted. Power tillers are also used in small rice fields, such as in Lafia, which will be discussed later. The current status of mechanization in the rice-growing areas is described below.

[92] According to NCAM, rotary work with a tractor is less frequent than that with a disk plow and disk harrow.
[93] Rice Mechanization Strategy (draft), FMARD (2018)
[94] SURVEY REPORT ON AGRICULTURAL MECHANIZATION IN NIGERIA WITH SPECIAL FOCUS ON RICE CULTIVATION, 2016, JICA Nigeria office.
[95] According to agricultural mechanization in Nigeria as well as IFPRI (2017) and FMARD officials, animal power is mostly used in the northwest and northeast, with one-pair and/or two-pair animal power.
[96] As explained by a staff member in charge of agricultural extension research at NAERLS, when agricultural machinery is introduced in areas with many small-scale farmers, the farmers sometimes retaliate and destroy or burn the introduced machinery, claiming that their jobs have been taken away.

4.5.2. Current status of mechanization in rice-growing regions

Farmers own several tens of hectares or more of farmland and work with service providers or use their own farm machinery. As described above, land preparation works are performed using agricultural machinery, such as plowing with a disc plow and harrowing with a disc harrow. Some farmers outsource only plows to a service provider and use a hoe for puddling and leveling works after rainfall or irrigation. In the case of direct seeding methods, some farmers sow seeds (manual broadcasting method) simultaneously during harrowing works with a disc harrow; in some cases, seeds are sown with a digging stick using the dibbling method or manually sown in rows using the drilling method after harrowing works. In areas where irrigation (or flooding in the fields) is available, a rotary must be used for puddling and leveling of the fields, although rotary use is not very common. Rice transplanting works are performed under irrigation/flooding in the field conditions in rainfall-dependent rice fields, such as rainfed lowlands, as shown in Photograph 4-2; in cases when the surface of the field is already drying by the time of transplanting, problems may arise. Both photographs below show very poor field conditions in terms of puddling and leveling works.

Photograph 4-2 Rice transplanting in a dry field (left) and conventional planting method (right)
Source: Provided by NCAM

In the northern zone, even though annual rainfall is only 700 mm, Kano and the neighboring states of Jigawa and Sokoto are major rice-growing regions in the country. All these states are home to agricultural areas where two to three rice crops can be grown annually by irrigating from rivers or using groundwater[97]. Particularly during the dry season, from around October to February, a high yield of 6 ton/ha can be achieved due to low pest and diseases incidence and large diurnal ambient temperature variations[98]. In the northern part of the country, in addition to large-scale rice cultivation, cassava, groundnut, and maize are grown with the use of agricultural machinery (tractors, disk plows, disk harrows, and ridgers) for the land preparation. However, this is also a poor area, and many small farmers work as laborers for large-scale farmers.

The southern zone is blessed with abundant rainfall throughout the year, although mechanization has not progressed much. This is because the soil is heavy due to high clay and moisture content, and there are many marshy areas without a hardpan where machinery sinks (bogged down), according to FMARD. In paddy fields with heavy rainfall and poor drainage, there are many losses due to delays in harvesting and lodged paddy[99].

[97] According to FMARD, rice can be cultivated in three cropping seasons using irrigation water; however, most farmers produce rice in two seasons; horticultural crops, such as vegetables, are also grown.
[98] NAERLS Agricultural extension officer
[99] FMARD

In the central zone, Makurdi in Benue State and the adjacent states of Nasarawa, Taraba, Kogi, and Niger produce 400,000 to 600,000 tons of rice annually, as mentioned above. Although some parts of Naija State have irrigation facilities from the Niger River, most of the central zone has rainfed lowland rice-growing areas.

4.5.3. Rice production in Lafia, Nasarawa State[100]

Nasarawa State, adjacent to the east of the capital Abuja, is a rainfed lowland area that produces about 400,000 tons of rice annually. According to the farmer the team visited, they use a stream that runs year-round or pump to draw groundwater for irrigating their crops in two seasons. Since groundwater can be pumped up from a few meters to as deep as 10 meters, many farmers use engine pumps (gasoline) with a diameter of 2–3 inches. Rice is the major cash crop that can be sold readily, and water pumps are essential for farmers in rainfed lowland areas.

Fuji Robin EY20 (3 inch)

China made (3 inch)

Photograph 4-3 Farmer-owned water pump

Source: Survey team

Upland crops, such as rice and horticultural crops, are planted during the rainy season, from June to August. Rainfall and year-round streams are used to irrigate rainfed rice fields. However, rainfall during the harvest season can lead to lodged paddy and delay harvest. During the dry season, the water level in the creek drops; thus, some farmers build a temporary weir for irrigation. Rainfed uplands are on higher ground than rice fields, and mixed cropping with cucumbers, maize, peanuts, and Egusi is practiced in areas with sandy soil (Egusi is a plant of the Cucurbitaceae family; the seeds are crushed and used in meat and vegetable soups. The locals call it melon).

Photograph 4-4 Rice-growing areas near Lafia

Stubble from the previous crop remains, and a water channel is seen.
One plot is 15 m × 30 m (0.05 ha by eye measurement)

Source: Survey team

[100] Lafia is the capital city of Nasarawa State, and the visit was limited to the city of Lafia.

Photograph 4-5 Upland fields adjacent to rice-growing areas

Source: Survey team

The farmer who works with his brother, owns rice fields in Photograph 4-4 cultivates rice in an 18.5 ha paddy field, 1.5 ha of which is upland rice cultivated once a year. They have been growing rice since their parents' generation and are thus experienced in rice cultivation. According to the farmer, one needs not worry about the sales channels for rice and it is also a profitable product. Currently, they work with their family and cultivate cassava and soybean, in addition to rice.

Photograph 4-6 Cassava cultivation on higher ground than in Photograph 4-5

Source: Survey team

The farmer uses machinery from their parents, and currently owns a second-hand Massey Ferguson (price and power not confirmed), 3-disc plow for the tractor, three power tillers [a Thailand Kubota RT110, 11 hp (towing-type), a Pakistan-made KWM120, 12 hp (towing-type), and a China-made 14 hp driven-type], a reaper (Yanmar), two threshers (Chinese made and Yanmar), a winnowing machine, and two pumps (Photograph 4-7).

The tractor and power tillers are operated by them, as they easily break down due to rough operation if operators are hired. After plowing work with a disc plow attached to a tractor, puddling and leveling works are performed with power tillers. If the farmers have enough time, they offer machinery services to the neighboring farmers (service charges depend upon the field conditions).

Photograph 4-7 A Pakistan-made power tiller and a towing-type puddling rotor

Source: Survey team


Photograph 4-8 Thailand Kubota power tiller (left) and Yanmar (Indonesia) thresher (right)
(The engine of the thresher is a Chinese hopper-type 14 hp)
Source: Survey team

According to the farmers, they conduct daily and ordinary maintenances of the machinery by themselves. For repairs, such as an injection pump, they avail services from repairmen in Lafia workshops. Although Japanese machinery is lightweight and has good operability, the price of its spare parts is relatively higher than that of Chinese machinery and the parts are not always easily available. According to them, even agricultural machinery made in China can last longer if used with care and subjected to regular maintenance.

Farmers hire laborers (neighboring farmers) for manual rice transplanting work. For one ha, around 25 people are required for a day's planting work, and each person is paid NGN 1,000 (270 yen), totaling approximately NGN 25,000 (6,710 yen) /ha. The farmers use their own reaper for harvesting, but they hire laborers because they cannot complete harvest by themselves. However, to complete all harvesting works, the farmers hire laborers, which costs approximately NGN 25,000 to 30,000 (6,710‐8,050 yen) /ha. In recent years, it has become more difficult to gather a large number of laborers during rice planting and harvesting seasons and labor wages have begun to rise.


Photograph 4-9 Machinery repair shop in Lafia
Maintenance is not limited to agricultural machinery. Various vehicles, including automobiles, can be repaired. In the back right corner of the photograph (left), a car is being serviced. Photograph on the right shows a tractor whose engine has been serviced. Frequent power outages and procurement of parts for various vehicles are the major issues.
Source: Survey team

4.5.4. Service providers

Tractor Owners and Hiring Facilities Association of Nigeria (TOHFAN) provides agricultural machinery services to farmers and others using 568 tractors and various work equipment (implements). The owners of the farm machinery are independent of TOHFAN and entrust TOHFAN with everything, from tractor maintenance to machinery services, and receive a portion of the sales. In other words, the machinery owner is an investor in TOHFAN's business. When an owner providing tractors and implements to TOHFAN purchases machinery, the initial investment is NGN 10–17 million (2.7–4.6 million yen) for purchase

depending on the type (brand) of tractor; NGN 40,000–50,000 (10,730-13,420 yen) for registration; and NGN 55,000–65,000 (14,760-17,440 yen) for the installation of a tracking device[101] to monitor the operational status of the machinery. According to TOFHAN, investors who purchase machinery can recover their original investment in approximately 3 years. TOHFAN is responsible for daily maintenance and services, but the tractor owner bears the cost in case of breakdown. TOHFAN also provides advice to owners (investors) who are not familiar with machinery on selecting the right model and horsepower (60–75 hp). Commonly selected tractors include John Deere, Massey Ferguson, New Holland, Mahindra, Farmtrack, and CASE, all of which have local distributors and dealers and whose parts are readily available. Of the 568 tractors, only 10 are four-wheel drive[102]. Tractor operators learn to operate and maintain tractors under the guidance of distributors/dealers, and when they are judged to be qualified, they receive a certificate of completion as an operator from TOHFAN. TOHFAN has an office in Zaria, Kaduna State, and provides services in all 36 states of the country, with a focus on the northern zone; however, they are unable to adequately respond to farmers' requests.

According to TOHFAN, the machinery service charge and human labor costs per hectare are as follows: NGN 25,000 (6,710 yen) for plowing with a tractor; NGN 35,000 (as NGN 1,000 × 35 people; 9,390 yen) for manual plowing, NGN 12,500 (3,350 yen) for harrowing; NGN 17,000 (as NGN 1,000 × 17 people; 4,560 yen) for manual work; NGN 13,000 (2,620 yen) for mechanical seeding; and NGN 20,000 (as NGN 1,000 × 20 people; 5,370 yen) for manual sowing; overall, contracted manual labors is very expensive.

TOHFAN used to have a John Deere combine harvester, but it broke down and is not in use. According to TOHAN, the cost of harvesting with a combine harvester is NGN 90,000 (24,150 yen)/ ha, and contracted labor for reaping to threshing and winnowing is more costly.

A large combine harvester (manufacturer and width unknown)

A Chinese combine harvester (approx. 2 m width)

Photograph 4-10 Wheel-type combine harvesters used in Nigeria

Source: Provided by NCAM

There are some critical views of TOHFAN's business[103]. There have been cases of disputes over the cost of agricultural machinery in the event of breakdown or accident. As mentioned above, tractor owners

[101] Tractor owners can select from Hello Tractor, Gambus, or EA Track.

[102] Although 2WD tractors are mainstream, they are rarely used in wet or flooding rice fields. If the rice fields are dry, 2WD tractors can be used.

[103] Opinions of government officials and consultants in the agricultural sector.

invest in TOHFAN (entrusting them with the use of agricultural machinery); however, in the event of breakdown, damage, or accidents, they cannot verify the details and must bear the cost of repairs without being able to determine the cause. As for the operators, some of them are still at the "beginner" level, even if they receive a certificate of completion. In this survey, the team was not able to get the opinions of owners who provided machinery to TOHFAN; however, the problem with this system is evident, as operator error could well be the cause of a fatal breakdown.

Agricultural machinery from Japanese manufacturers is not used. The main reason is that there are no distributors/dealers.

4.5.5. Post-harvest processing works

Most of Nigeria's rice is parboiled before milling processes[104]. In the parboiling process, the paddy grains are soaked in warm water (around 70°C) or room temperature water and then steamed or directly boiled. The Rice Processors Association of Nigeria (RIPAN), as described below, has members who are medium- and large-scale rice millers, and they own automated parboiling process equipment. Meanwhile, members of the Lafia Rice Millers and Dealers Association perform the parboiling and milling processes separately. The equipment used by the members of each association is summarized below.

(1) Rice Processors Association of Nigerian

RIPAN has its headquarter in Abuja, the capital of Nigeria. RIPAN has 50 members, who are rice millers. The average rice (paddy) processing capacity of mills is 2–3 tons per hour, and the annual amount of rice processed is at least 10,000 tons and at most 80,000 tons, with the average annual amount of rice processed being 50,000 tons. In the parboiling process at large-scale rice mills, paddy grains are soaked in hot water at 70 °C for several hours (with a moisture content of 30–35%), as described above. Next, water is drained, and the soaked grains are steamed to gelatinize starch. After steaming, the grains are dried in a circulation-type mechanical dryer to reduce the moisture content to 14–15%. The dried grains are placed in a storage tank, where milling and separation (color sorting and broken rice separation) processes occur. During these processes, rice is passed through belt conveyors and bucket elevators. Although the details of parboiling and milling process equipment at RIPAN headquarters could not be confirmed, the entire process from parboiling to packaging is automated. Some of the 50 members (millers) own 1,000 ha of rice fields or larger, and their main concern is how to collect as much dried grains as possible after harvest.

(2) Lafia Rice Millers and Dealers Association

The team did not have the opportunity to visit any large-scale rice mill during this survey. This section describes small-scale rice mills in Lafia, Nasarawa State[105]. In Lafia, there is Lafia Rice Millers and Dealers Association, which has 750 members, including brokers who buy dried grains from farmers, dealers who buy and store the purchased dried grains (locally called markets), parboiling processers (parboilers), rice

[104] Ogawa, T., et. al. 2021. In Japan, until around the middle of the Edo era, some rice (red rice with long grains) imported from China was parboiled, mainly in the Kyushu and Shikoku areas. However, because of its inferior taste, it was treated as a low-grade rice, and the parboiled process was discontinued after the Meiji Era. Parboiled processed rice in the Edo Era (in Japanese). [Edo Jidai no Parboiled Kako Mai]. Agriculture and Horticulture. Yokendo.

[105] Refer to JICA Report (2016), "Report on the Completion of Project Work for the Project to Strengthen Rice Postharvest Processing and Marketing Capacity, Nigeria."

mill owners, and buyers (wholesalers) of white rice[106]. Due to frequent power outages in the area, the rice milling machines (mostly Engelberg-type machines) are driven by 14–26 hp diesel engines.

According to the Chairman of the association, there are nearly 180 rice mills that are owned by the members and 325 rice milling machines; each rice mill has around two rice milling machines. The total amount of white rice after milling per day across all rice mills is 150 tons. The mills are in operation for around 300 days a year, except on Sundays and Christmas. Rice mills process 150 tons per day for 300 days, producing 45,000 tons of parboiled rice per year. Considering that the estimated annual per capita consumption of rice in Nigeria at around 40 kg, the white rice is processed can feed 1.13 million people.

Rice mills in Lafia do not weigh paddy grains, and they consider the volume (apparent specific gravity) of white rice after milling. For weighing, a cylindrical can (around 28 L) called a bushel (volume in pounds[107]) is used, which is considered to carry 20 kg rice. If the apparent specific gravity (or bulk density) of white rice is 0.8 kg/L, the one cylindrical can has 22 kg of white rice. However, the mass depends on how the can is filled with white rice, variety, moisture content of white rice, and amount of broken rice. In addition, rice mills also process rice that has been parboiled by farmers on their own[108] in a custom rice mill. In this case, the milling charge is NGN 10 (2.7 yen) per kilogram of white rice. The process of parboiling to milling using an Engelberg-type machine is as follows:

Parboilers or rice mills purchase paddy grains directly and carefully separate immature grains, empty grains, and chaff, using a winnower and wind. The key to producing uniform parboiled rice is to align the grains as much as possible. If there are immature grains, the bran layer penetrates the endosperm, resulting in darker white rice. Thereafter, the grains are soaked in hot water at 70 °C for 5 to 8 hours in a drum specially designed for soaking to allow the soaked grains to absorb enough water. After soaking, using a huge drum, as shown in Photograph 4-11, winnowed immature grains (including some empty grain and chaff) are placed at a height of 20 to 30 cm from the bottom of the drum, and then rice bags (made of polyethylene) are laid on top of the immature grains and filled with water up to that height. Rice bags are used like perforated plates in a steam cooker. Finally, the soaked grains are placed in a huge drum until it is full and steamed.

The fuel is firewood. At around 7 a.m., the grains after steaming were already spread out on a sheet to dry, as seen in the rear of the photograph.

Rice bags are used as perforated plates of a steam cooker over immature grains.

Photograph 4-11 Steaming grains

Source: Survey team

[106] There are two types of rice mills: those that also perform parboiling and those that specialize in milling process only. In the former case, rice millers buy dried grains (commercial rice millers). In the latter case, rice millers are the so-called custom rice millers (milling processer).

[107] Although there are differences between Europe and the United States, a bushel has a volume of 35–36 L.

[108] Some rice farmers in Lafia sell all paddy grains they harvest. This is because the parboiling process is very labor intensive. Such farmers buy white rice from rice mills or retail stores in town.

Grains must be steamed evenly. There was no lid on the drum. Immature grains at the bottom of the drum are locally called *Shampi*, which are also dried and milled for consumption.

Grains spread on a sheet to dry after steaming.

Boiled *Shampi* at the bottom of the drum.

Photograph 4-12 Grains after steaming

Souse: The survey team

Most of the mills monitor moisture content (dryness) of grains by chewing them. Previously, the state government had provided a resistance-type moisture meter, but it broke down. Dried grains are put into the Engelberg twice to be milled. Underneath the friction-type Engelberg, there is a polisher made of cowhide that removes bran powder from the surface of white rice.

Two-pass milling process by Engelberg

Polishing device, which removes bran powder from the surface of white rice. It is installed under the machine.

Photograph 4-13 Rice milling machine (Engelberg) in use at the site

Source: Survey team

Measuring container of white rice, called Bushel

White rice right after milling process. The color is uneven; some grains are broken, and husk has remained on some grains.

Photograph 4-14 White rice after milling process

Source: Survey team

After milling process, the price of white rice can be negotiated with the buyer because the rice quality can be clearly evaluated. White rice is sold per can (one bushel, around 20 kg) and costs approximately NGN 325–375 (87–101 yen)/kg.

In addition, a one-pass rice milling machine was distributed to farmers in Nasarawa State, but an Engelberg-type machine is also used locally. However, as shown in Photograph 4-15, the screen of the whitening section of the one-pass milling machine seems to be less durable than that of the Engelberg-type machine and can be easily damaged.

Photograph 4-15 Damaged screen of the rice whitening section

Source: Survey team

White rice in Abuja and Lafia is packaged in bags of 25 or 50 kg and sold at retail. The price converted to 1 kg is approximately NGN 400–600 (107–161 yen).

As mentioned above, some rice farmers sell all of their harvest and buy parboiled white rice. Similarly, farmers in other countries consider it more advantageous to sell all harvest and earn wages as harvesting laborers for other farmers with a sickle in their hands rather than carrying the harvested rice from the field to the drying site, drying and parboiling it, as practiced in Nigeria. Some large-scale rice farmers in Australia, the United States, and other countries also outsource the harvesting work, sell all harvest as undried paddy grains, and buy white rice for consumption at home.

4.6. Agriculture inputs (seeds, fertilizers, and agrochemicals)

4.6.1. Seeds

Seed quality is important to improve crop productivity; however, CS remains at the early stages of adoption for crops other than maize in Nigeria. In 2019, CS (rice) production was only 39,245 tons[109], which is very less compared with the required amount of 149,375 tons[110]. Few farmers use CS (rice), and many still use their own seeds. This also applies to horticultural crops.

In Nigeria, the National Cereal Research Institute (NCRI), Africa Rice, and Green Agriculture West Africa (GAWAL) (private company) produce BS (rice). FS (rice) and CS (rice) are produced by FS/CS production and marketing companies[111] registered with the National Agriculture Seeds Council (NASC). According to NASC, as of June 2021, there were 305 FS/CS production and marketing companies. Companies holding an FS production license for rice include Premier Seeds, Value Seeds, Kojoli Farm, Romarey Seeds Ventures, Ideal Mustard Seed, NCRI Business, GAWAL, and IITA GoSeed[112], among others.

FARO44 and other high-yield/early-maturing rice seeds are mainly used in Nigeria[113]. The

[109] NASC (2020) Annual Report
[110] NRDS2
[111] It is not possible to get a license for producing and selling FS/CS at the same time. As an exception, Premier Seeds and Value Seeds hold a license for both production and marketing.
[112] NCRI Business is a subsidiary of NCRI, and IITA GoSeed is a subsidiary of IITA for BS/FS sales.
[113] In Northern Nigeria, the use of FARO 44, 52, 61, and 59 and GAWAL R1 is recommended [USAID (2020) Guide to Rice Production in Northern Nigeria]. Production of BS, FS, and CS for rice and other crops is detailed in the annual reports of NASC (https://seedcouncil.gov.ng/statistics/).

Nasarawa Agricultural Development Programme (NADP) sells FARO44 with subsidies to farmers in the state. In addition, farmers in the Lafia area use FARO44. The characteristics of CS (rice) sold by NADP to farmers are presented in Table 4-10.

Table 4-10 CS (rice) distributed to rice farmers in Nasarawa State

Variety	Habitat/adaption	Tillering capacity	Potential yield (ton/ha)	Days to maturity (days)	Plant height (cm)	Tolerance
FARO44	Irrigated lowlands/shallow swamps	High	8.3	95–115	100–115	Blast
FARO52		High	7.9	125–13	115–125	Iron toxicity, drought
L19		Medium	7.9	~125	~120	NA

Source: Prepared by the survey team based on USAID (2020) Guide to Rice Production in Northern Nigeria and interviews with NCRI

NADP procures the FS of FARO44, FARO52, and L19 from NCRI at NGN 1,000/kg. Moreover, NADP conducts germination tests and then distributes FS to CS farmers. NADP buys CS from the CS farmers at an approximately NGN 50–100 higher price than the market value (2021: NGN 800/kg). After another germination test, CS is sold through three regional offices (2021: NGN 700 kg/ha). IITA GoSeed sells FARO44 and FARO52 BS at NGN 1,260/kg and FS at NGN 700/kg online[114].

In Nigeria, a company must be registered with the NASC to produce and sell the FS/CS of crops, including rice. Seeds must be registered according to the "Guidelines for Registration and Release of New Crop Varieties in Nigeria" published by the National Center for Genetic Resources and Biotechnology (NACGRAB) in 2016[115]. Japanese companies are welcomed to expand their business in the seed sector in Nigeria.

4.6.2. Chemical fertilizers

Interviews with rice farmers and related associations and organizations revealed that the main fertilizer used in Nigeria is NPK20-10-10[116]. In Nigeria, the proportion of cultivating households using chemical fertilizers is 41.4% and that using organic fertilizers is 5%[117]. NRDS2 plans to increase the amount of using chemical fertilizers from the current 60 kg/ha to 100 kg/ha of nitrogen (N), 45 kg/ha of phosphorus (P), and 45 kg/ha of potash (K) in the future[118].

In Nigeria, the Presidential Fertilizer Initiative has been implemented since 2016[119]. Under the initiative, the import of NPK was banned in stages starting in 2018 and completely in 2020. Currently, 44 fertilizer blenders are involved in this initiative, which allows them to purchase diammonium phosphate (DAP), potassium chloride (MOP), and urea (Urea) at lower market prices. Kwandare Fertilizer Blending

[114] IITA GOSeed website (https://iitagoseed.com/shop/)

[115] Seeds must be tested at crop research institutions, such as NCRI, for rice and at the National Horticultural Research Institute (NIHORT) for horticultural crops. According to NCRI, the cost of rice field experiments (three seasons), including all necessary expenses, is approximately NGN 21.6 million.

[116] In addition to NPK20-10-10, other popular fertilizers are NPK15-15-15, NPK20-10-10, NPK12-12-17+2MgO, and NPK27-13-13 [IFDC (2020) Fertilizer Statistics Overview Nigeria 2015-2019].

[117] Sheahan M., Barrett, C.B (2014) Understanding the Agricultural Input Landscape in Sub-Saharan Africa: Recent Plot, Household, and Community-Level Evidence. In addition, according to an agricultural expert in the JICA Nigeria office, few farmers use chemical fertilizers, because the use of urea is not allowed in northeastern Nigeria due to its use as a raw material for weapons of terrorism.

[118] FMARD (2020) NRDS2

[119] A framework for domestic production (blending) of NPK by creating an enabling environment for investments by the private sector.

Company Nigeria in Nasarawa State purchases raw materials under this initiative and sells NPK20-10-10 or NPK in proportions as requested by farmers[120]. Anyone can buy the fertilizer by visiting the factory; however, it is difficult for farmers in rural areas to visit the factory. Therefore, farmers buy it through dealers, meaning they pay more than the factory price.

The Fertilizer Producers and Suppliers Association (FEPSAN), which supervises the initiative, welcomes Japanese investment in the local fertilizer manufacturing industry. Kwandare Fertilizer Blending Company Nigeria has also expressed interest in partnering with Japanese companies.

NADP sells a bag (50 kg) of NPK20-10-10 at NGN 5,000, while its market price is NGN 8,000–8,500. However, this is the price at which NADP sells the fertilizer, and the price may vary when the fertilizer reaches the farmers who use it. For instance, at a fertilizer store in Lafia, a bag (50 kg) of NPK20-10-10, marked as NGN 5,000 was sold at NGN 6,000.

Photograph 4-16 NPK20-10-10
It costs NGN 6,000 (1,610 yen) per bag (50 kg) (Lafia)
Source: Photographed by the survey team

The FMARD Farm Inputs Support Services Department (FISSD) is responsible for fertilizer registration[121]. According to FISSD, for fertilizers already registered in the Economic Community of West African States (ECOWAS), a field verification test is not required. Fertilizers can be sold after analyzing ingredients in a laboratory in Nigeria. Since 2020, manufacturers, compounders, importers, and distributors of fertilizers are required to register with the FISSD National Fertilizer Management Platform[122] (NFMP). FISSD recommends that Japanese companies that are interested in fertilizer or agrochemical business should first visit FISSD.

4.6.3. Organic fertilizers

Organic fertilizers are gradually becoming popular in Nigeria. For instance, SUPER GRO (5L), an organic liquid fertilizer manufactured in South Africa, was sold at NGN 20,000 in an agricultural input shop in Abuja and for NGN 15,000 in Lafia. Nasam Global Resource, a local company, produces liquid organic fertilizer made from domestic animal manure, rice husk, wood chips, and indigenous microorganisms. The company sold 50,000 liters of organic fertilizer in 2020. According to the CEO, liquid organic fertilizer production is expected to further increase in 2021.

Photograph 4-17 Liquid organic fertilizer SUPER GRO
Source: Photos by the survey team

[120] According to the FMARD Farm Input Support Service Department (FISSD), there is no fixed price from the government; however, according to Kwandare Fertilizer Blending Company Nigeria, it must be sold within a certain price range.
[121] It is responsible for inputs (fertilizers and pesticides) for the agriculture and livestock sector.
[122] It includes guidelines for importers of fertilizers and their raw materials, as well as guidelines for businesses that manufacture fertilizers and build fertilizer blending plants (https://nfmp.gov.ng/).

4.6.4. Agrochemicals

In Nigeria, approximately 33% of the total number of cultivating households use agrochemicals[123]. Various types of agrochemicals, including herbicides and insecticides, are available for sale. The main types of pesticides and their prices in Abuja and Lafia are listed in Table 4-11.

Table 4-11 Varieties, prices, and countries of origin of agrochemicals sold in Abuja and Lafia

Variety	Name	Price (NGN)	Country of origin	City
Herbicide	Round Up	NGN 2,000/1,000 mL NGN 1,800/1,000 mL	Belgium	Abuja Lafia
	Slasher	NGN 1,800/1,000 mL	China	Abuja
	SPAMNE	NGN 2,000/1,000 mL	China	Abuja
	Round Up Turbo	NGN 2,300/1,000 mL	Belgium	Lafia
	RELISATE	NGN 1,500 /1,000 mL	Nigeria	Lafia
	KRIS	NGN 2,500/1,000 mL	India	Lafia
	MIAGROTOPSHOT	NGN 6,500/500 mL	China	Lafia
	Bracer	NGN 1,500/100 mL	China	Lafia
	BISPYRICE	NGN 1,500/100 mL	China	Lafia
	Rice Pro	NGN 4,000/1,000 mL	India	Lafia
	Super AMINE	NGN 2,000/1,000 mL	India	Lafia
Insecticide	PERFECT KILLER	-/1,000 mL	China	Abuja
	CYPERCAL	NGN 2,000/1,000 mL	India	Abuja
	BERLLA	NGN 2,500/1,000 mL	China	Abuja

Source: Survey team

Many products were herbicides and most are made in China or India. Round Up, a non-selective herbicide[124], is available for sale in Abuja and Lafia, but the price in Abuja is NGN 200 higher than that in Lafia. In Lafia, a local herbicide, called RELISATE manufactured by Reliable Agro Allied, is sold. Although not found in stores, Nasam Global Resource locally manufactures a biological pesticide containing edible oil, spices, and tree extracts.

The National Agency for Food & Drug Administration & Control has prepared various guidelines for pesticide registration. FISSD will be responsible for registering pesticides in the future.

4.7. Advanced agricultural technologies

4.7.1. Drones

Drones are increasingly being used for rice production in Nigeria. Customers of BEAT Drone, a company that provides drone services to farmers, use drones for mapping, spraying fertilizers and pesticides, and monitoring crop status. Of its 15,000 customers, 12,000 are rice farmers. BEAT Drone offers drone services to spray fertilizer and pesticide and monitor crop

Photograph 4-18 Spraying fertilizer by BEAT Drone

Source: Provided by BEAT Drone

[123] Sheahan M., Barrett, C.B (2014) Understanding the Agricultural Input Landscape in Sub-Saharan Africa: Recent Plot, Household, and Community-Level Evidence.

[124] It is an herbicide intended to control all weeds growing in the area where it is sprayed, and is effective against most types of plants (http://lib.ruralnet.or.jp/nrpd/#koumoku=14460).

status to Olam, which has 10,000 ha of land in Nasarawa State.

According to BEAT Drone, most drones in use in Nigeria are made in China. Chinese drones are popular because they are affordable and their spare parts are readily available. Meanwhile, according to Airshot Drone, a company that provides drone services in Abuja, Chinese drones are only for hobbyists, and better-quality drones are required for business.

4.7.2. Agriculture applications and farming support system

(1) Hello Tractor

Hello Tractor is a company that connects tractor owners providing agricultural machinery services with farmers willing to receive cultivation services by linking GPS-equipped tractor loggers with an application developed by the company. Using the logger, tractor owners can monitor each registered tractor's cultivation area, operation time, travel distance, and fuel history. In addition, the tractor owners can confirm maintenance items and schedule in the application and search for a mechanic nearby [125]. The company has deployed over 2,500 tractors with its technology since 2015, serving over 500,000 farmers[126].

Figure 4-12 Business image of Hello Tractor

Source: Website of Hello Tractor

(2) Farm Innovation Nigeria

Farm Innovation Nigeria supports the improvement of the farmers' productivity through an application called Farm Aid developed by the company. Farm Aid allows farmers to connect with various partners of Farm Innovation Nigeria, such as service providers[127], microfinance banks (MFBs), and brokers. Farmers can access Farm Aid to receive advice on farming from Farm Innovation Nigeria's agricultural experts (there are three) or weather information. Farmers can use Farm Aid for free or for a fee (NGN 2,000). Currently, 43,856 farmers use Farm Aid, over 1.7 million SMSs for sharing information have been sent, and over 150,000 calls have been made[128]. Farm Innovation Nigeria is interested in partnering with Japanese companies.

4.8. Access to finance

4.8.1. Bank of Agriculture (BOA)

BOA was established in 2001 as the Nigeria Agricultural, Cooperative and Rural Development Bank by the Government of Nigeria and the Central Bank of Nigeria and took its current name in 2007. BOA has over 200 branches in Nigeria, and 70% of their customers are agricultural workers (farmers or agricultural production and processing corporations). Bank's loans are categorized as small-to-large-scale loans according to the loan amount, as shown in Table 4-12.

[125] https://hellotractor.com/
[126] https://wfpinnovation.medium.com/hello-tractor-innovating-in-the-agri-sharing-economy-85b9de3e8688
[127] There is a company called Trucktruck, although no information is available on the web.
[128] https://www.farmaid.net/ (accessed on June 8, 2021)

Table 4-12 BOA loan classification

Categorization	Minimum and maximum loan amount	Annual interest rate	Repayment period
Small-scale loan	NGN 50,000–250,000 （13,420–67,080 yen）	12% (loans to the production sector) 20% (loans to the processing sector)	Depends on the crop (including livestock products), but most are short-term loans of approximately a year
Large-scale loans (individuals)	NGN 1 million–5million (268,330–1.3 million yen)	14% (loans to the production sector) 20% (loans to the processing sector)	Depends on the crop (including livestock products), but most are approximately 1–3 years
Large-scale loans (Corporate)	NGN 5 million to 1 billion (1.3 million – 268 million yen)	Same as above	Same as above
	Up to NGN 10 billion (2.7 billion yen)	To be determined through negotiation	To be determined through negotiation

Source: Survey team

Small- and large-scale loans (individual) can be borrowed by both individual farmers and farmer groups. The main purpose of loan is as working capital. Generally, fewer loans are provided for purchasing agricultural machinery to both individuals and corporations, although loans may sometimes be provided if both the recipient and the bank agree.

BOA has also implemented a number of loan programs for the agricultural sector in collaboration with FMARD and the Central Bank of Nigeria. One such program is the BoA–FMARD Collaboration on Mechanization Intervention Program. This program was implemented as part of the country's Agriculture Transformation Agenda (ATA)[129]. The program targets farmer groups in rural communities or providers of wage farming services to farmers[130]. Farmers and service providers pay 20% of the total amount of agricultural machinery and materials to the BOA as a deposit, and the remaining 80% is repaid over 4 years at an interest rate of 7%[131]. The program was divided into two phases; the first phase was operational from 2014 to 2018 and the second phase from 2016 to 2020. As shown in Table 4-13, agricultural machineries were introduced to 80 communities in the first phase and 60 communities in the second phase[132].

Table 4-13 Number of agricultural machineries introduced to each community through the Mechanization Intervention Program

Machinery	Quantity in phase 1	Quantity in Phase 2
Tractor	5	3
Disc plough	5	3
Disc harrow	5	2

[129] The agenda was launched by the former President (President Jonathan) and implemented by FMARD with the support of the African Development Bank. The objectives are to attract private investment in the agricultural sector, increase the value of local agricultural products, and promote farmers' access to markets and finance. African Development Bank Group (2013) Agricultural Transformation Agenda Support Program – Phase 1 (ATASP-1) STRATEGIC ENVIRONMENTAL AND SOCIAL ASSESSMENT (SESA) EXECUTIVE SUMMARY

[130] It is called AEHE (Agricultural Equipment Hiring Enterprise)

[131] Interest is charged on the total amount of materials and equipment, and the amount including the interest is paid in installments over 4 years.

[132] FMARD (2016) Private Sector Driven - Agricultural Mechanization Programme (PSDAMF) and GES Application Strategy of Nigeria

Machinery	Quantity in phase 1	Quantity in Phase 2
Disc ridger	5	2
Motorized tillers	5	0
Tipping trailer	1	1
Mini combine harvester	2	0
Rice thresher	1	0
Maize sheller	1	0

Source: Prepared by the survey team based on materials obtained from BOA

In addition to the Mechanization Intervention Program mentioned above, there are programs for young farmers and agribusinesses in the age group of 18–35 years[133], programs for women involved in agriculture[134], and short-term loans for crop marketing activities, all of which are mainly used to raise working capital.

4.8.2. Commercial banks

There are 23 commercial banks in Nigeria[135]. Ecobank and First City Monument Bank (FCMB), for instance, have established agriculture desks; however, the share of agriculture in their overall portfolio is very low (12–15% for Ecobank and only 11% for FCMB). Due to the high inflation rate in Nigeria, the general interest rate for commercial banks is high, reaching 20%[136].

Ecobank does not offer any of the bank's own financial products that are specific to the agricultural sector. Ecobank provides agricultural loans through commercial loans[137] and the Anchor Borrowers' Programme (ABP) described below. The annual interest rate for commercial loans is up to 20.5%, which can be reduced to 16% for larger loans (around NGN 1 billion or 268.33 million yen). Commercial loans are available only to large-scale commercial farmers, agricultural cooperatives, and agricultural production corporations, while small-scale farmers are encouraged to use the microfinance banks with which Ecobank is affiliated.

FCMB provides working capital loans to rice millers, agro-processors, and traders and also leases tractors to farmer groups, tractor owner associations, and service providers[138].

Both banks are PFIs in the ABP of the Central Bank of Nigeria, with Ecobank leading in the wheat and maize sectors and FCMB in the rice sector. PFIs raise loan resources from the Central Bank of Nigeria at a low interest rate (2%) and provide loans to farmer groups[139] or "anchor companies" that process agricultural

[133] BOA website (https://www.boanig.com/services4/youth-agricultural-revolution-nigeria/)
[134] BOA website (https://www.boanig.com/services4/grow-and-earn-more/)
[135] List of Financial Institutions, Central Bank of Nigeria
[136] The annual interest rate for commercial banks in Nigeria was 11.24% as the preferential lending rate and 28.64% as the maximum rate as of April 2021 data. https://www.cbn.gov.ng/rates/mnymktind.asp.
[137] The maximum repayment period is 5 years.
[138] According to interviews with FCMB, they purchase tractors from vendors on behalf of their customers and the customers can acquire the tractors by repaying the tractor cost within the repayment period (3–4 years) at an annual interest rate of 20%. This program has been implemented over four batches thus far and has served over 300 customers. https://businesszone.fcmb.com/agric-business.
[139] Groups of 5 to 20 people. Central Bank of Nigeria (2020) Anchor Borrowers' Programme Guidelines

products at an annual interest rate of up to 9%[140]. Considering that the general interest rate of commercial banks is high (around 20%) and that the inflation rate in Nigeria has been over 10% in recent years, 9% is the preferential interest rate. Farmer groups purchase inputs and farm machinery essential for production or receive services from anchor companies or agricultural machinery service providers and then sell their crops to anchor companies after harvest. The loan amount is repaid to the PFI by the anchor company.

To date, Ecobank has extended loans to 20,000 farmers under ABP through all its branches, with the total amount of loans reaching NGN 8 billion (approximately 2.1 billion yen). Overall, commercial banks provide loans to the agricultural sector through the Central Bank of Nigeria's schemes, such as ABP, rather than through their own financial products.

4.8.3. Microfinance banks

There are 976 MFBs with operating licenses in Nigeria[141]. According to the Central Bank of Nigeria's definition, MFBs fall into the following three categories[142]:

a) Unit MFB: MFBs licensed to operate at only one specific location, with a minimum capitalization of NGN 20 million (approximately 5.4 million yen)
b) States MFB: MFBs licensed to operate within a particular state or federal capital territory (FCT, including Abuja). They may establish branches and ATMs within the state. Minimum capitalization is NGN 100 million (USD 26.83 million)
c) National MFB: MFBs licensed to operate throughout Nigeria. They can establish branches in FCTs and all states. Minimum capitalization is NGN 2 billion (537 million yen)

According to a survey conducted by Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ), MFBs provide loans to the agricultural sector at a monthly interest rate of 2.5–5%[143]. Specifically, the Bank of Industry (BOI)-affiliated MFBs, as discussed below, provide loans to food processors and traders, including livestock products, at a monthly interest rate of 4%.

MFBs also offer loans to the agricultural sector through the above-mentioned ABP and other schemes of the Central Bank of Nigeria, such as the Agricultural Credit Guarantee Scheme Fund[144] and the Agri-Business/Small and Medium Enterprise Investment Scheme[145]. Nonetheless, the share of agriculture in their portfolio is low[146].

4.8.4. Bank of Industry

BOI provides loans to the agricultural sector, particularly to the processing sector. BOI does not

[140] The amount of the loan to the farmer group (or anchor company) will be agreed upon by the project management team comprising representatives from PFIs, the farmer group, the anchor company, and the Central Bank of Nigeria. Central Bank of Nigeria (2020) Anchor Borrowers' Programme Guidelines
[141] List of Financial Institutions, Central Bank of Nigeria
[142] Central Bank of Nigeria website (https://www.cbn.gov.ng/FAQS/FAQ.asp?category=Microfinance)
[143] GIZ (2015) Loan Pricing of Nigerian Microfinance Banks: Survey & Methods of Assessment
[144] In this scheme, a fund from the Central Bank of Nigeria guarantees up to 75% of the defaulted amount. https://www.cbn.gov.ng/devfin/acgsf.asp.
[145] A loan program for start-up companies and small and medium enterprises in the agricultural sector. https://agsmeisapp.nmfb.com.ng/.
[146] For example, at AMBA Microfinance Bank, the rate is around 30%.

provide loans to the production sector; thus, farmers are not eligible for loans but companies, such as crop processors and rice millers, are.

Since 2013, BOI has been implementing its own financial product, the Cottage Agro-Processing Fund, which provides working capital loans at an annual interest rate of 9% to small- and medium-sized enterprises in the processing sector for the purpose of procuring raw materials (agricultural and livestock products), equipment, and maintenance and operation facilities.

BOI is classified as a development finance institution[147], similar to BOA, which means that the bank does not give top priority to its own interests but rather raises funds from international institutions, such as the African Development Bank, to provide loans at low interest rates. As a result, 70% of the BOI's overall portfolio is loans to the agro-processing sector (including the livestock industry). In addition to the Cottage Agro-Processing Fund mentioned above, the Rice & Cassava Intervention Fund[148], which is funded by FMARD and targets rice millers and cassava processors, is being implemented.

4.9. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team.

4.9.1. Basic policy for the establishment of AFICAT (draft)

Nigeria has the largest population and GDP in SSA, and the need for increasing food production is extremely high. According to some Japanese companies, the size of the market is very attractive, partly because agricultural mechanization in Nigeria is lagging behind compared with that = in Tanzania and Ghana. Meanwhile, in Nigeria, due to the impact of COVID-19 and security issues, field activities were restricted to the capital city and areas within 8 hours one way by vehicle from the capital city and below safety risk level 2 set by the Ministry of Foreign Affairs (as of May 2021). In addition, Japanese experts are not allowed to visit areas with the safety risk levels 3 and 4. Although Japanese companies are highly interested in the Nigerian market, many of them are concerned about the lack of security.

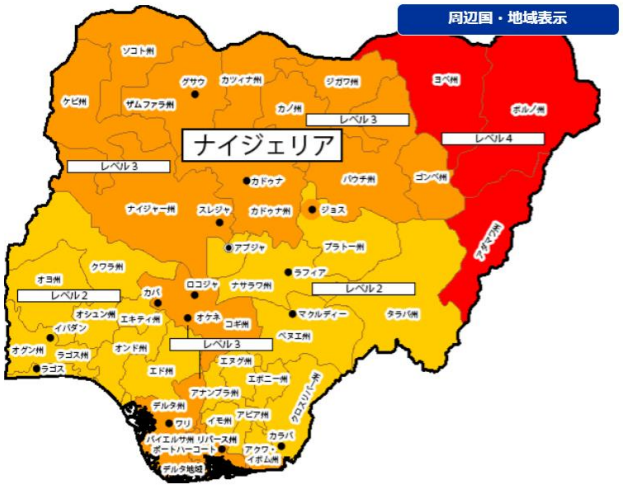


Figure 4-13 Safety Risk level before the impact of COVID-19

Note: Yellow indicates level 2, orange indicates level 3, and red indicates level 4

Source: Website of the Ministry of Foreign Affairs

Therefore, the basic policy is to initiate AFICAT activities on a small scale and in a feasible manner, focusing on locations

[147] According to the Central Bank of Nigeria, a development finance institution is defined as "a specialized financial institution established with a specific mandate to develop and promote key sectors of the economy that are considered strategically important to the country's overall socio-economic development goals." Central Bank of Nigeria (2014) Regulatory And Supervisory Guidelines for Development Finance Institutions (Dfis).

[148] BOI website (https://www.boi.ng/wp-content/uploads/2017/06/AGP-PRODUCT.pdf)

that Japanese companies and experts can visit and to gradually expand the activities to other areas in cooperation with the relevant local organizations as the activities progress.

Information was collected through online discussions with government agencies at locations that could not be visited during this survey or by requesting their representatives to visit Abuja for discussions. In the case of AFICAT activities, it is necessary to prepare a draft activity plan considering that the areas that Japanese experts can travel to may vary depending on the security situation.

In Nigeria, an advisor on agricultural development has been dispatched to FMARD, and a technical cooperation project on rice seeds is being planned with NCRI as the main C/P. In addition, the possibility of a grant aid project to provide agricultural machinery is being considered[149]. NCRI has six rural stations in Nigeria and provides agricultural machinery services, such as land preparation tractors, to contract farmers (out-growers) who produce seeds. By incorporating AFICAT activities into the JICA technical cooperation project on rice seeds, verifications and demonstrations of Japanese agricultural machinery can be conducted, although activities will be limited to rice production. The schedule of the related JICA projects is assumed to be as shown in Table 4-14.

Table 4-14 Operation schedule of the related JICA projects (draft)

Period	outline
By January 2023	▪ Dispatch the agriculture development advisor
After April 2023	▪ Start JICA technical cooperation project on rice seeds ▪ Within the framework of the JICA project, AFICAT functions will be expanded to include the verification and demonstration of Japanese agricultural machinery.

4.9.2. Candidate institutions/locations for collaboration with AFICAT (draft)

As the National Rice Desk Officer and the Director of Engineering and Mechanization are assigned in the FDA of FMARD, AFICAT operations can be efficient if FDA serves a contact function for AFICAT (e.g., AFICAT desk). In addition, since an agricultural development advisor has already been dispatched to ABM, which is in charge of post-harvest processing, it is desirable to form a structure in which the advisor takes the lead in rice promotion and agricultural mechanization in cooperation with the Federal Capital Territory Administration (FCTA), Nasarawa state government, NCRI, NCAM, and other related organizations.

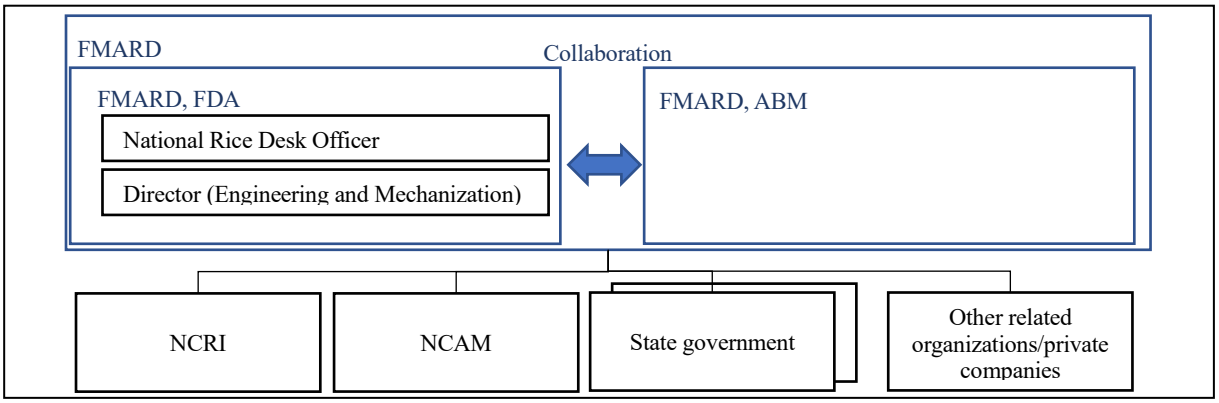


Figure 4-14 AFICAT establishment (draft)

[149] Interview with the JICA Nigeria Office (on June 4, 2021)

Figure 4-15 shows the location of the major relevant agencies/facilities related to rice promotion and agricultural mechanization. FMARD and NCRI are the main government agencies for rice promotion, and FMARD and NCAM are the main government agencies for agricultural mechanization. However, NCRI is located in Niger State and NCAM in Kwara State, which Japanese experts cannot visit as of May 2021. Therefore, AFICAT activities will start from Abuja, where FMARD is located, as well as FCTA and the neighboring Nasarawa State government (specifically, the Agricultural Development Program of each state), which the Japanese experts can visit, and the scope of activities will be expanded as the project progresses and/or the safety risk level improves.

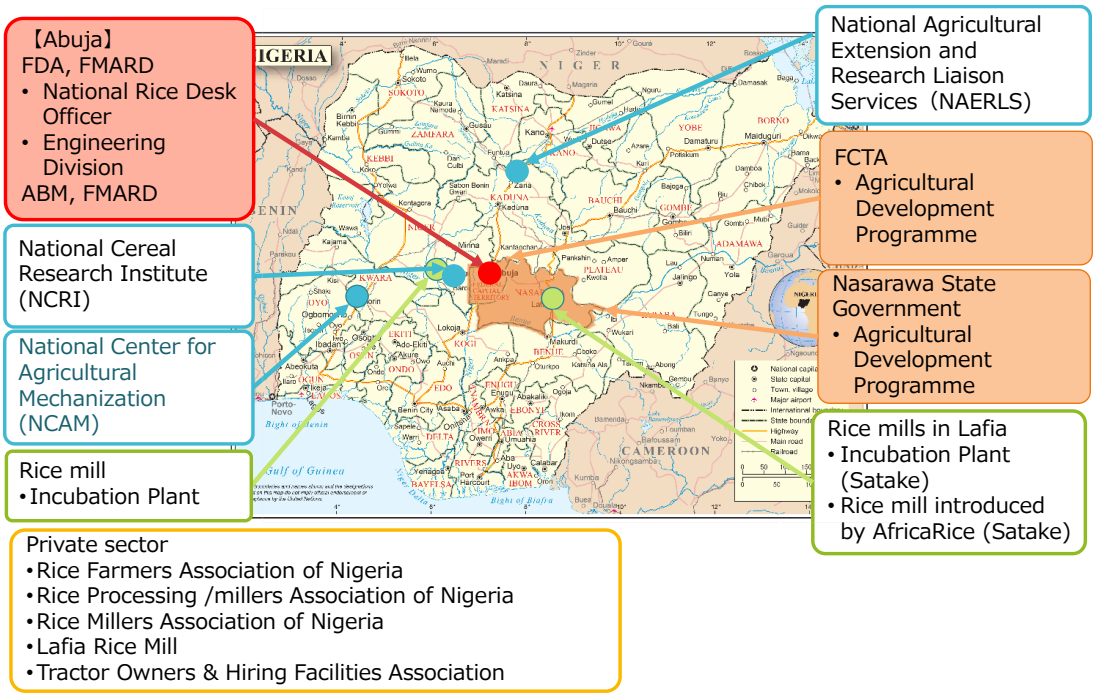


Figure 4-15 Locations of institutions/facilities related to rice promotion and agricultural mechanization

As mentioned above, the places where Japanese experts can work are limited because of COVID-19 and security issues; thus, it is difficult to determine where AFICAT will be based. In the premises of the Nasarawa State Agricultural Office in Lafia City, which the team was able to visit during the survey, there is a building where agricultural machines and parts can be stored. However, as shown in Photograph 4-19, it is old and needs rehabilitation.

On the premise that JICA technical cooperation projects had been conducted in Lafia, Nasarawa State, and good relations with Japan have been established, AFICAT functions (2), (3), and (7) can be initiated in Lafia, as described below. As mentioned above, Lafia in Nasarawa State is an area where rice cultivation, various field crops, and post-harvest processing (including parboiling) are very active.

AFICAT obtained a cost estimate of NGN 4.19 million (1.12 million yen) from the Nasarawa State Office for the rehabilitation of the old building to be used as a warehouse for Japanese agricultural machinery and parts, as shown in Table 4-14. This estimate includes toolboxes and the minimum necessary machine tools.

Table 4-15 Cost estimate for the rehabilitation of old shed

ESTIMATE FOR RENOVATION OF PROPOSED AFICAT OFFICE AT NADP WORKSHOP, LAFIA NASARAWA STATE, NIGERIA

S/NO	DESCRIPTION OF ITEMS	QTY	UNIT	RATE	AMOUNT
A.	**ROOFING WORK**				
Dismantling of flat roof Office/Store and re-construction of new gable roof with replacement of galvanized zinc, hardwood, ceilings and labour as required.					
1	Galvanize Zinc	12	bdl	30,000	360,000
2	2x4 hard wood	350	No	700	245,000
3	2x2 soft word	150	No	500	75,000
4	Brazil Ceiling/Offices/Caves)	25	No	4,000	100,000
5	Battern	2	bdls	6,000	12,000
6	Zinc Nails	6	plots	3,000	18,000
7	Wooden Nails (4"/3")	2	bags	15,000	30,000
8	Ceiling Nails (1½"	30	pans	700	21,000
9	Facia Board	25	No	2,000	50,000
10	Labour		Sum	-	250,000
	Sub-Total				**1,161,000**
B.	**BLOCK WORK**				
Re-building of existing flat roof block walls to gable wall level and fence the Offices/Store surroundings with blocks as required.					
1	9"Blocks	300	no	300	90,000
2	6" Blocks	2,000	no	200	400,000
3	Sharp Sand	2	trips	25,000	50,000
4	Concrete cover for fence	1	trip	25,000	25,000
5	Fence Protector	7	Rolls	30,000	210,000
6	Cement (Dangote)	45	bags	4,000	180,000
7	Labour mason/labourers		Sum	-	250,000
	Sub-Total				**1,205,000**
C.	**DOORS/WINDOWS/GATE WORK**				
Construction of new gate, replacement of damaged doors, windows, protectors and broken glasses as required.					
1	Gate	1	No	180,000	180,000
2	Iron Door	1	No	35,000	35,000
3	Door Frame	1	No	20,000	20,000
4	Window Frame	1	No	20,000	20,000
5	Window protectors	3	No	20,000	60,000
6	Window glasses	6	Pcs	700	4,200
	Total				**319,200**
D.	**FLOORING/PLASTERING**				
	Plastering all built walls and screeding of floors as required.				
1	Plastering Sand	2	trips	30,000	60,000
2	Sharp Sand	1	trip	30,000	30,000
3	Cement (Dangote)	30	bags	4,000	120,000
4	Labour		Sum		180,000
	Total				**390,000**
E.	**PAINTING WORK**				
General painting of both internal and external walls of Offices/Store, workshop and fence work as required.					
1	Emulsion paint	35	drums	6,000	210,000
2	Oil paint	20	gallons	6,000	120,000
3	Labour		sum	-	130,000
	Total				**460,000**
F.	**WELDING MACHINES/TOOL BOX**				
	Purchasing of new welding machines, drilling machines, disc cutter and five (5) sets of mechanical tool box as required.				
1	Welding machines	1	No	110,000	110,000
2	Drilling machine	1	No	40,000	40,000
3	Disc Cutter	1	No	50,000	50,000
4	Five (5) sets of tool box (mechanical)	5	No	90,000	450,000
	Total				**650,000**
				NGN Total	**4,185,200**
				Converted to yen	**1,123,000**

Photograph 4-19 Old machinery shed at the Nasarawa State Agricultural Office in Lafia
Source: Survey team

4.9.3. Proposed seven functions of AFICAT

As mentioned above, in Nigeria, it is expected to start small-scale activities in collaboration with FCTA and the Nasarawa State governments, through FMARD as the contact point, and gradually expand activities to other areas as the project progresses. The seven functions and activities of AFICAT that could be implemented are listed below.

- ✓ Function 1: Advice
  - Technical advice from Japanese experts to CPs
  - Recommendations to the Nigerian Government through the verification of agricultural machinery and value chain
  - Provision of information to Japanese companies
- ✓ Functions 2 and 3: Exhibition, verification, and demonstration
  - Exhibition of agricultural machinery using workshops and other facilities owned by FCTA or the Nasarawa State government
  - Verification and demonstration of agricultural machinery using farmers' fields and demonstration plots (tractors, combine harvesters, various work implement, power tillers including small ones, sluice management systems, and sensing technology)
  - Promotion of the introduction of Japanese products in cooperation with local rice mills, domestic rice marketing companies, and industry organizations. If possible, verification of the business model from harvesting to drying
- ✓ Function 4: Finance
  - Introduction of various financial schemes for Japanese manufacturers
  - Promotion of the demonstration of agricultural machinery in cooperation with financial institutions
- ✓ Function 5: Innovation Lab
  - Verification and joint research with NCAM, NCRI, and other related organizations
- ✓ Function 6: Public relations
  - Public Relations, mainly with FMARD
- ✓ Function 7: Human resource development
  - The following personnel will be trained:
    - ➢ State government workshop technicians and local mechanics
    - ➢ Owners and operators of agricultural machinery in FCT and Nasarawa State

4.9.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

- ✓ Agricultural machinery
  - Agricultural mechanization in Nigeria lags behind compared with that in Tanzania and Ghana. Nigeria's area under paddy cultivation and paddy production volume are the largest in SSA, and the market is very large. However, there is a serious concern regarding security, and it is difficult for Japanese experts to work here. Therefore, AFICAT will conduct verifications and demonstrations in places where Japanese experts can work, and the related organizations will be invited to places where the Japanese experts can visit and conduct activities.
  - Agricultural machinery will be imported through a loan from the Brazilian government and will be assembled and sold under soft loans in Nigeria. In some cases, state governments provide subsidies (in the case of the Jigawa State government, subsidies are used to reduce the price by 62–65%), making it difficult for the Japanese companies to sell similar type of agricultural machinery without any financial arrangements in Nigeria. AFICAT can provide information on the types and prices of subsidized agricultural machinery to Japanese companies as a reference when they enter the SSA market.
  - In terms of rice production, the level of mechanization for land preparation is not very advanced. Combine harvesters must be introduced with caution due to the possibility of depriving farmers of labor opportunities and possibility of opposition from the community.
  - Even major Japanese agricultural machinery manufacturers do not have local agents or dealers, because they have not prioritized Nigeria as their market. It is necessary to start with the selection of distributors and dealers. In interviews, many Japanese companies (44%) pointed out that there is lack of information on distributors and dealers; thus, AFICAT is expected to provide information on potential distributors and dealers as one of its functions.
- ✓ Rice mills
  - Parboiled rice is mainstream in Nigeria. Japanese manufacturers do not produce parboiled rice processing equipment. However, it is possible to produce parboiled rice processing equipment to meet the overseas demand. Large rice milling plants in Nigeria are equipped with parboiled rice processing equipment, and many of the products made in India and China are used for paddy processing (machines that soak, steam, and dry paddy).

Chapter 5. Current Status of and Issues Related to Agricultural Mechanization in Tanzania

5.1. Outline of the agriculture sector

5.1.1. Agriculture overall

The agricultural sector is one of the main industries in Tanzania, and although its share of GDP has decreased significantly from 42.0% in 1990 to 26.2% in 2000, it maintained nearly a quarter of GDP at 26.7% in 2020[150]. Considering that the actual GDP increased 3.3 times from USD 17 billion (1.879 trillion yen) to USD 56.6 billion (6.257 trillion yen) during this period, the agricultural sector has indeed supported Tanzania's rapid growth[151]. Although the percentage of workers engaged in agriculture has decreased from 84.67% in 1991 to 65.9% in 2019, a large portion of the population is engaged in agriculture even today[152].

The country produces mainly cassava (8.18 million tons), maize (5.65 million tons), sweet potato (3.92 million tons), sugarcane (3.59 million tons), and rice (paddy) (3.47 million tons), being the world's tenth largest producer of cassava, 23rd largest producer of maize, 21st largest producer of rice, and 4th largest producer of sweet potatoes[153].

5.1.2. Rice production

Rice is the second major grain in Tanzania following maize. Rice production jumped from 890,000 tons per year in 2009 to 2.28 million tons (white rice equivalent) in 2018, making Tanzania the third largest rice producer in SSA following Nigeria and Madagascar. One of the reasons for the rapid increase in rice production in Tanzania is thought to be the increase in rice consumption due to changing consumer preferences and ease of preparation. The fact that "if you make rice, you can sell it" motivated farmers to produce more rice and expand their rice cultivation areas. Another reason for the expansion of production is that the use of agricultural machinery has allowed working at the right time of the year, increasing yield and reducing losses. As a result, Tanzania has already met its domestic demand and is aiming to contribute to self-sufficiency within the East African region.

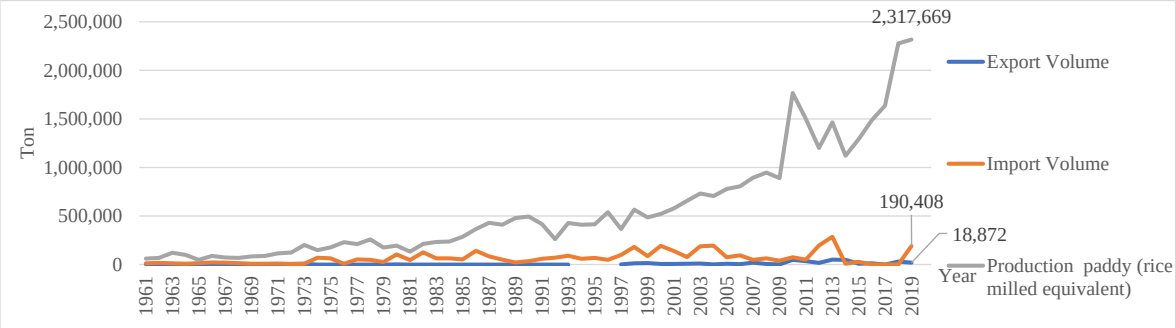


Figure 5-1 Trends in rice production, import, and export in Tanzania

Source: FAOSTAT

[150] WB (web) World Development Indicator
[151] (Same as above)
[152] (Same as above)
[153] FAOSTAT

As shown in Figure 5-2, Tanzania's agro-ecological zones can be roughly divided into alluvial plains, arid lands, coast, isolated granitic mountains, highlands (northern, southwestern, southern and western), plateaus, and semi-arid areas. As shown in Figure 5-3, the top five rice-producing regions in Tanzania are Morogoro, Mbeya, Tabora, Pwani, and Shinyanga, which produce 82.9% of the country's rice[154]. As shown in Figures 5-2 and 5-3, among the agro-ecological zone, rice production is high in southern highlands, plateaus, and semi-arid and coastal areas.

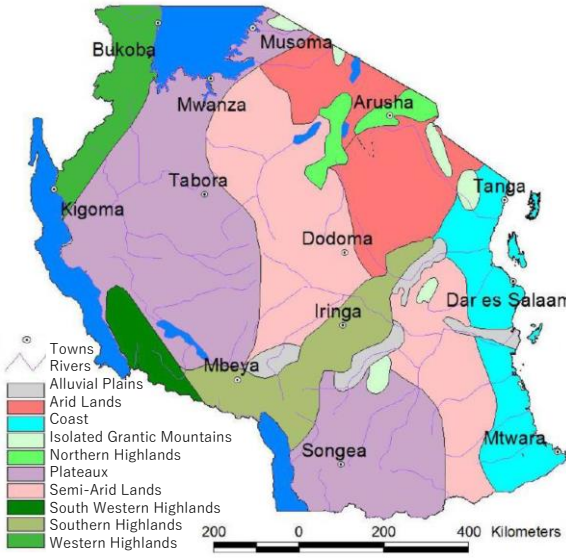


Figure 5-2 Agro-ecological zones in Tanzania
Source: Tanzanian Government (2017) Agricultural Sector Development Programme Phase II

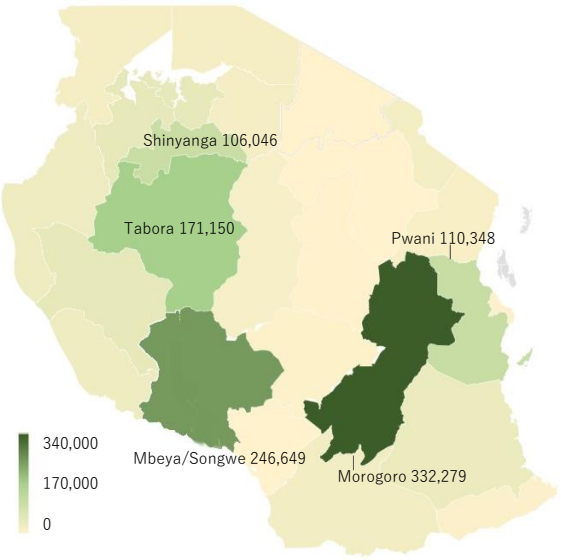


Figure 5-3 Major rice-producing regions in Tanzania (ton)
Source: Prepared by the survey team based on NBS (2018) 2016/17 Annual Agriculture Sample Survey Crop and Livestock Report

In Tanzania, 71% of rice is cultivated in rainfed lowlands, 9% in irrigated lands, and 20% in rainfed uplands[155]. Figure 5-4 shows the general rice cropping calendar in Tanzania. In rainfed uplands, rice is produced once a year, with planting starting around November and December when the light rainy season begins. In irrigated areas, there are two cropping seasons. In lowland areas below 500 meters above sea level, cropping is practiced year-round if water conditions are good. The cropping season is determined by discussions with the local government agency in charge of the irrigated area and the water users' association.

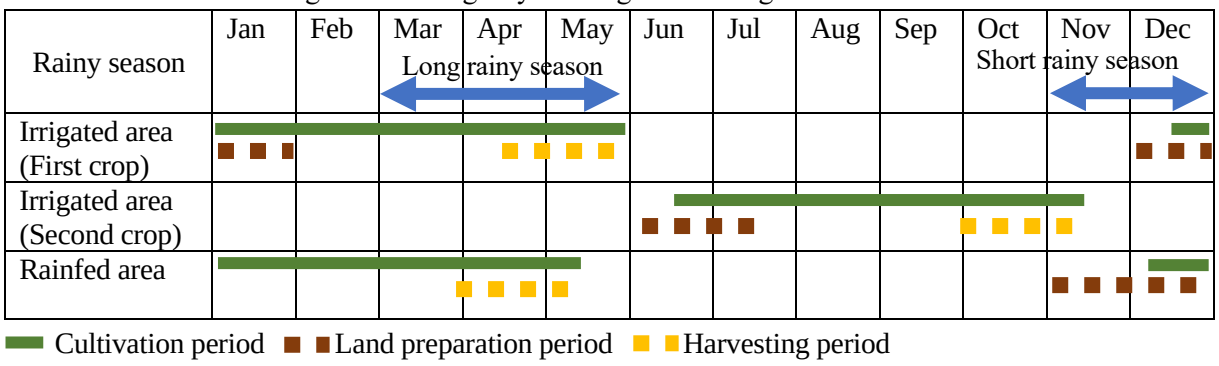


Figure 5-4 Rice cropping calendar in Tanzania

Source: Survey team

[154] NBS (2018) 2016/17 Annual Agriculture Sample Survey Crop and Livestock Report
[155] NRDS2

5.2. Outline of the major stakeholders

5.2.1. Ministry of Agriculture

The Ministry of Agriculture, Food Security and Cooperatives was restructured to the Ministry of Agriculture, Livestock and Fisheries in 2016 and further re-structed to the current Ministry of Agriculture in 2017. The organizational chart of the Ministry of Agriculture is shown in Figure 5-5.

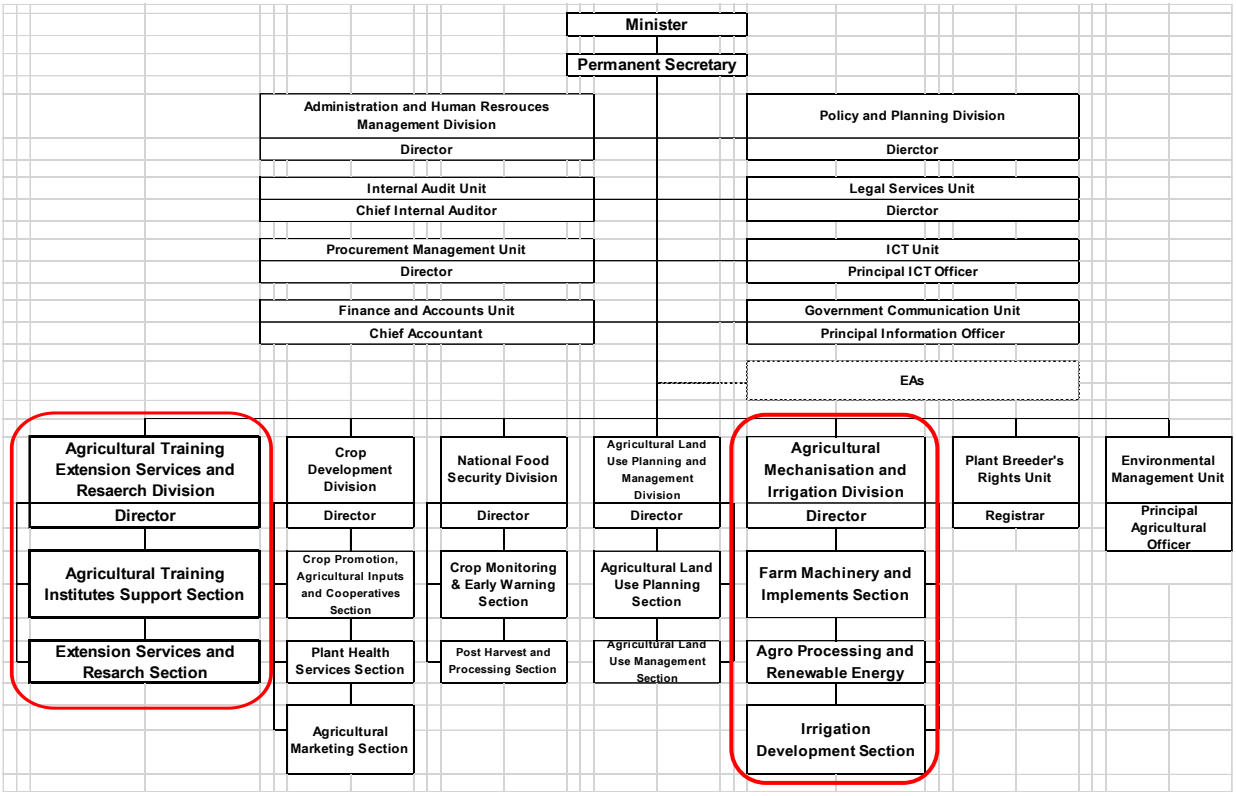


Figure 5-5 Organogram of the Ministry of Agriculture

Source: JICA (2019) Rice Promotion Capacity Enhancement Project detailed planning study report

(1) Agricultural Mechanization and Irrigation Division

Although the division is in charge of agricultural mechanization and irrigation, majority of its 22 staff members are in charge of mechanization. Irrigation is handled only by the coordination unit, and the National Irrigation Commission is in charge of irrigation practices. In addition to the Director General, three Acting Directors are assigned to handle the duties of the Director General. One of them is in charge of mechanization and NRDS2 formulation as a focal person. The Permanent Secretary has been appointed as a focal person of CARD.

(2) Agricultural Training, Extension Services, and Research Division

It is in charge of training, extension, and research within the Ministry of Agriculture and has jurisdiction over the Ministry of Agriculture Training Institute (MATI), which includes the Kilimanjaro Agricultural Training Center (KATC). It also serves as the contact point for the Tanzania Agricultural Research Institute (TARI).

MATI is mainly responsible for secondary education before entering colleges and universities.

Students from level 4 to 6 of the National Technical Award, which is the national education system in Tanzania, study there. After 2–3 years of education, students are awarded a Certificate or Diploma. As shown in Figure 5-6, there are 14 MATIs in Tanzania, and KATC is one of them. Among all MATIs, only MATI Mlingano has an agricultural machinery course.

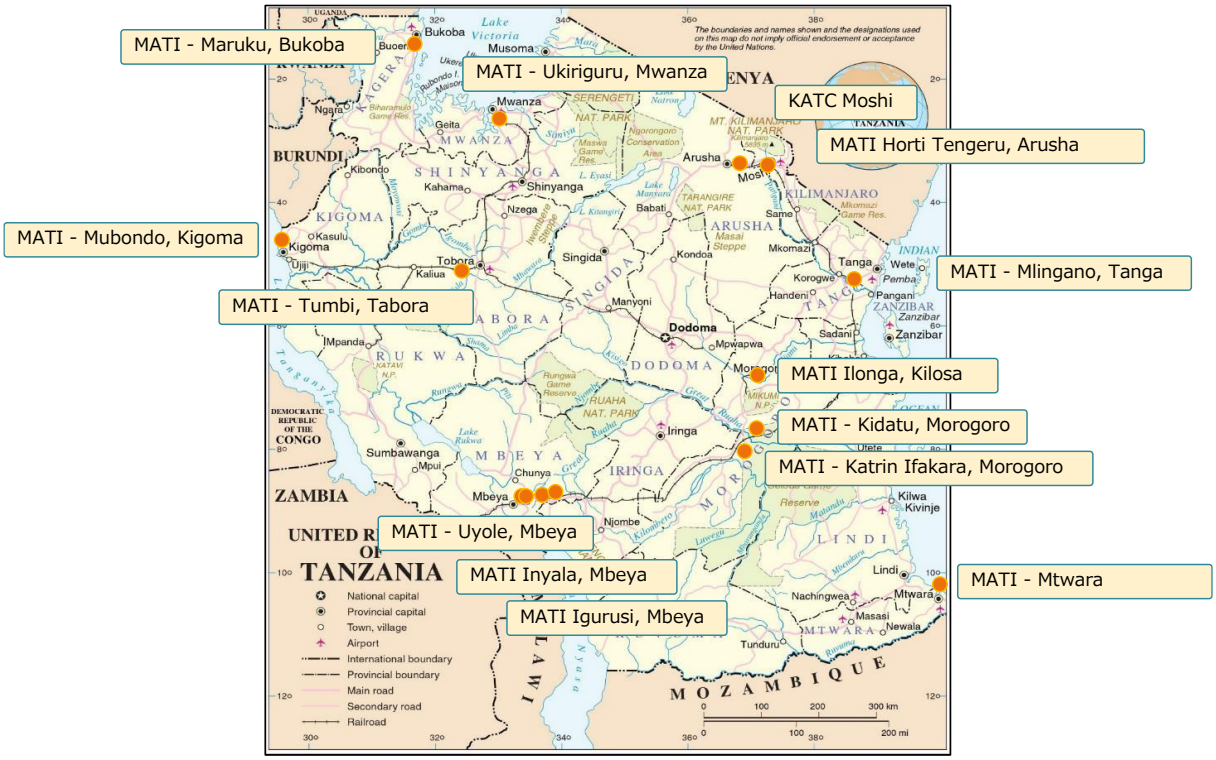


Figure 5-6 Names and locations of MATIs

Source: MATI website

Kilimanjaro Agricultural Training Center

KATC was originally a training center owned by the Kilimanjaro regional government, but it was transferred to the national government in 1994 and positioned as a part of MATI. JICA has been supporting KATC since when it was called the Kilimanjaro Agricultural Development Center (KADC) under the Kilimanjaro regional government[156]. KATC was the base of operations for the JICA Project for Supporting Rice Industry Development (TANRICE 2), which ended in 2019, and will also be the base of operations for the JICA Project for Strengthening Capacities of Stakeholders of Rice Industry (TANRICE 3), a follow-up project of TANRICE 2. KATC has a wealth of resources, such as agricultural machinery, human resources, and plots, due to its long-time support.

Due to accommodation limitations, the maximum number of students accepted is 65; however, accommodation for farmers is under construction with support from JICA (as of July 2021). KATC has 21 instructors and 9 supporting staff members (accountants, supply officers, cleaners, and drivers). It has 4.8 ha of irrigated land and 4.5 ha of upland. Irrigated land is divided into 0.3 ha (30 m × 100 m), 0.2 ha, and 0.15

[156] KATC was called Kilimanjaro Agricultural Development Center (KADC) when it was first established. KADC was established as a training center for rice cultivation in Kilimanjaro, particularly in the Lower Moshi irrigation scheme, in conjunction with the construction of the Lower Moshi irrigation scheme.

ha for the use of rice trials, demonstrations, student training, and irrigation for upland crops[157]. Two of the plots have been netted to prevent damage from animals (mainly birds) for rice research purposes. KATC is also conducting research on rice in cooperation with the International Rice Research Institute (IRRI) and the Japan International Research Center for Agricultural Sciences (JIRCAS).


KATC main building


Lecture room


Office room


Machinery of Japanese brands (right: workshop and equipment storage)


Rice and maize mill


Experimental plot with a net


Insect-proof greenhouses for horticultural crops


Paddy drying area and seedling nursery


Paddy fields and new accommodation facilities under construction

Photograph 5-1 KATC facilities

Source: Survey team

MATI Mlingano

It is located in Muheza District, Tanga Region, approximately 300 km north of Dar es Salaam, around 5 hours by car. Tanga Region is a major producer of sisal hemp, one of the export products, and tractors and other agricultural machinery have been used since early times for land preparation and transportation. The main purpose of MATI Mlingano is to provide training on agricultural mechanization, specifically the use of upland crop machinery for sisal and maize. However, as of July 2021, only one tractor and a few implements (disc plows and harrows) were in operation. The office and accommodation facilities are being renovated with funds from Tanzanian government. The accommodation can host nearly 200–250 people. There are two courses, namely the Agricultural Machinery Course and Agricultural Production Course, with 50 and 112 students enrolled, respectively. The land area is more than 120 ha, but there is no irrigated land

[157] When KADC was established, there were 16 plots of 0.3 ha, according to the Japanese plot standards.

due to lack of water[158].


Discussion with the Principal of MATI Mlingano


Classroom


Accommodation facility under renovation


Office rooms under renovation


Field of sisal


Field for maize


Warehouse of machinery (right: implement introduced 1970s)


The only tractor in operation (with flat tire)


The Principal also delivers lectures


Drip irrigation (source is tap water)

Photograph 5-2 MATI Mlingano

Source: Survey team

(3) Tanzania Agricultural Research Institutes (TARI)

To strengthen agricultural research in Tanzania, various agricultural research institutes in the country were merged in 2016 to form TARI. As an independent institution under the Ministry of Agriculture, TARI's mission is to conduct, regulate, promote, and coordinate all agricultural research activities conducted by public and private research institutions and organizations in Tanzania.

Its headquarters is located in Dodoma, the capital city, and it has a network of nine research institutes and eight sub-centers in the country. The location of each center and the research topics are summarized in Figure 5-7.

[158] Water for daily life is also sometimes scarce in this area.

Figure 5-7 Location and research topic of each TARI center

Source: Prepared by the survey team based on TARI website

5.2.2. Center for Agricultural Mechanization and Rural Technology (CAMARTEC)

CAMARTEC operates under the Ministry of Industry, Trade and Investment and is responsible for performance testing, certification, and development of agricultural machinery. It is based in Arusha Region, and all agricultural machinery sold in Tanzania, whether domestic or imported, must be tested and certified by CAMARTEC. When an agricultural machinery manufacturer or local distributor applies to CAMRTEC, they specify when and where inspections will be conducted. Since soil, crop, and other conditions vary depending on the area and the time of operation, CMARTEC selects a location that is representative of Tanzania. A combine harvester is run for 600 machine hours (hour meter proportional to engine speed) to detect problems, which can take 3 months or longer. Although CAMRTEC has its own operators, it often employs engineers and operators from the local government mechanization offices. The cost of the inspection depends on location, horsepower, and fuel consumption, among other factors. For instance, inspection of a tractor costs around TZS 25–50 million (1.2 to 2.39 million yen), but if multiple farm machines are inspected at once, the cost of inspecting the second machine can be reduced (the cost of inspecting the second machine is around 60% of the cost of inspecting the first one).

From 2018 to 2021, 79 models have been inspected by CAMRTEC. These mainly include tractors, combine harvesters, sprayers, and disc plows; however, tracking devices that automatically monitor tractors and other farm machinery are not covered.

In cooperation with the Tanzania Bureau of Standard (TBS) and customs, a system is being

established to restrict the import of agricultural machinery that does not have CAMRTEC certification.

5.2.3. Irrigation schemes

(1) Lower Moshi Irrigation Scheme

The irrigated area is 2,300 ha, of which 1,100 ha are for paddy grown in 2–2.5 cropping seasons per year, and the remaining 1,200 ha are for upland crops. According to the manager of the irrigation scheme and the agricultural extension officer who is an official of the Moshi regional government, 1,600 ha were planted with rice in 2.5 cropping seasons from 2020 to 2021. Farmers who use the Lower Moshi Irrigation Scheme are required to join the Lower Moshi Irrigators Association (LOMIA), which had nearly 3,700 members as of July 2021.

The Japanese government supported the construction of KADC (the predecessor of KATC) through grant aid as well as the establishment and dissemination of irrigation and rice cultivation technologies and tractor rotary tillage and land preparation methods (direct puddling or *unai-gaki*) through technical cooperation. As a result, the Lower Moshi Irrigation Scheme achieved a rice yield of 6/ha, which is higher than the national average[159].

Photograph 5-3 Paddy field in the Lower Moshi Irrigation Scheme

Each plot is 0.3 ha (100 m × 30 m)
Source: Survey team

(2) Mombo Irrigation Scheme

Mombo Irrigation Scheme is one of the irrigation schemes that received agricultural machinery from the World Bank's Policy and Human Resources Development Fund (PHRD). It is located in Korogwe District, Tanga Region, and has 220 ha of irrigated land, where 429 farmers mainly grow rice. Apart from the irrigation cooperative, the Mombo Irrigation Scheme Agricultural Cooperative Society (Mombo Cooperative Society) is organized, with 302 members out of 429 farmers using the irrigation scheme. PHRD has provided agricultural machinery and other equipment to 20 cooperatives in 20 irrigation schemes, and the Mombo Cooperative Society is one of the most successful cooperatives in the country, as it has been using the donated machinery to provide services to both internal members and external farmers and increasing the number of agricultural machinery. The details of mechanization in the Mombo Cooperative Society will be shown later.

[159] JICA website (https://www.jica.go.jp/project/tanzania/008/index.html)

Seedling bed before planting
(Taken on the same day as photograph on the right)

Fertilizer manufacturer demonstration
(Near harvest)

Photograph 5-4 Mombo Irrigation Scheme

Source: Survey team

5.2.4. Sokoine University of Agriculture

The Sokoine University of Agriculture is located in Morogoro, the capital of Morogoro Region. It was established in 1965 as an agricultural collage offering diploma programs and was renamed in 1984 as the Sokoine University of Agriculture. There are over 50 colleges and universities in Tanzania; however, the Sokoine University of Agriculture is only university that offers a wide range of degree programs in the agricultural sector[160], with 7,853 undergraduate students enrolled[161]. In addition to the main campus located 3 km south of Morogoro, there are two other campuses: the Solomon Mahlangu Campus (11 km northwest of Morogoro) and the Olmotonyi Campus (Arusha, mostly forestry).

The Sokoine University of Agriculture had a Department of Engineering Science & Technology as a faculty dealing with agricultural machinery, but it was upgraded to the School of Engineering Technology as of July 1, 2021. The School of Engineering Technology includes the Department of Agriculture Engineering, the Department of Civil and Water Resource Engineering, and the Department of Food Science and Agro-Processing Engineering. The school has tractors (15–20 units) and various implements for the maintenance of the university's fields and for classes, and the workshop has 10 technicians and a supervisor (who is also a faculty member).

Training room

Workshop

Maintenance room

Tractors and various implements

Photograph 5-5 Agricultural machinery depot at the Sokoine University of Agriculture and various agricultural machineries owned by the university

Source: Survey team

[160] Tanzania Ministry of Agriculture website (https://www.kilimo.go.tz/index.php/en/stakeholders/view/sokoine-university-of-agriculture-sua)
[161] 2015/16 Results. Sokoine University of Agriculture website (https://www.dpd.sua.ac.tz/index.php/facts/facts-and-figures)

5.3. Related Policies, strategies, and development plans

5.3.1. Agricultural Sector Development Programme (ASDP)

Following the implementation of ASDP from 2006/2007 to 2013/2014, ASDP Phase 2 (ASDP II) has been developed and a 10-year development program starting 2017/2018 has been finalized. ASDP II is divided into two phases. The first phase covers the 5-year implementation period from 2017/2018 to 2021/2022 and outlines the project budget and targets (indicators). The program aims to transform the agricultural sector, including crops, livestock, and fisheries, in terms of productivity enhancement as well as commercialization and income generation for smallholder farmers, thereby improving livelihoods and food and nutrition security, ultimately contributing to GDP. By supporting commercialization and value chain development, the program aims to transform small subsistence farmers into sustainable and competitive commercial farmers. The program identifies priority crops in each agro-ecological zone, with rice being a priority crop in the coastal areas (Lindi, Mtwara, Tanga, and parts of Pwani) and southern highlands (Mbeya, Iringa, Njombe, and parts of Morogoro).

Lack of mechanization is a major constraint for small-scale farmers in terms of improving agricultural productivity. Therefore, mechanization is essential for intensifying agricultural production, increasing the area under cultivation, and improving productivity by working at the right time. ASDP II aims to improve access to locally adapted agricultural services for increasing labor productivity, value addition, and farm income. Specifically, it aims to increase the proportion of cultivating households through mechanized services for tractors and power tillers from 17% to 40% over 5 years starting from 2017/2018.

5.3.2. National Rice Development Strategy

NRDS formulated in 2009 set a goal to increase paddy production from 900,000 tons in 2008 to 1.96 million tons by 2018. This required an increase in production per unit area from 0.5 to 2.13 ton/ha at that time to 1.6 to 3.5 ton/ha. To achieve this goal, a strategy was formulated in six areas: i) improved access to improved varieties and seed systems; ii) fertilizer marketing and distribution; iii) investment in irrigation and water management technologies; iv) access to and maintenance of agricultural machinery and equipment; v) research, technology dissemination, and capacity building; and vi) credit and agricultural finance.

The results in 2018 showed a steady increase in the area under cultivation, yield, and production of paddy. In particular, paddy production more than tripled in 10 years, reaching 3.41 million tons in 2018, far exceeding the target.

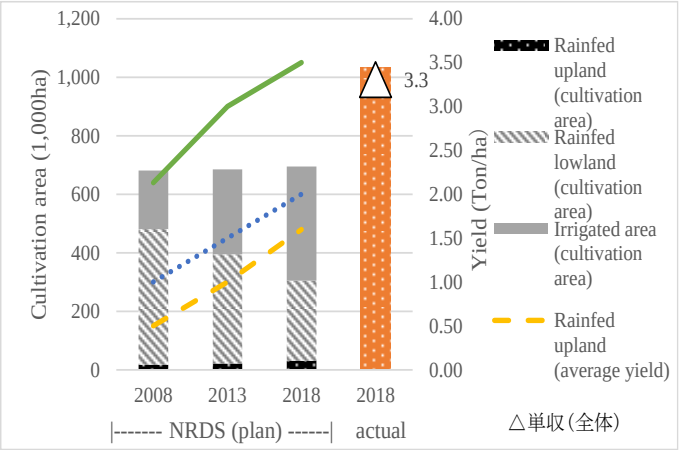


Figure 5-8 Planned and actual area and yield of NRDS (2009)

Note: The left axis shows cultivation area, and the right axis shows yield. The three bars on the left show planned values, and those on the far right show actual values.
Source: NRDS (2009) and FAOSTAT

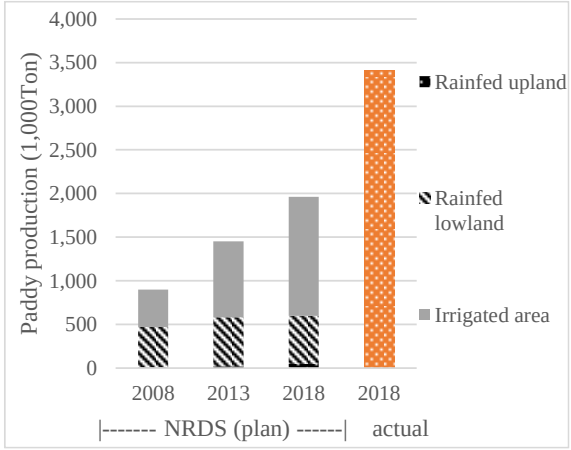


Figure 5-9 Planned and actual paddy production of NRDS (2009)

Note: The three bars on the left show planned values, and those on the far right show actual values.
Source: (Same as the left)

In 2019, NRDS2 was formulated, outlining the strategy for 2019–2030. NRDS2 aims to maintain rice self-sufficiency and increase the competitiveness of domestic rice by i) doubling the area under rice cultivation from 1.1 million ha (2018) to 2.2 million ha (2030); ii) doubling the paddy yield from 2 ton/ha (2018) to 4 ton/ha (2030); iii) reducing post-harvest losses from 30% (2018) to 10% (2030); and iv) promoting public-private partnerships and private investment. To increase paddy yield, it is necessary to work at the right time, and for this purpose, mechanization, use of soil testing kits, access to and appropriate use of inputs, and access to finance must be promoted. To reduce post-harvest losses, the NRDS2 targets include promoting the connectivity among manufacturers, dealers, post-harvest processing service providers, and small-scale farmers for ensuring timely harvesting, proper drying, and quality improvement. The target values of NRDS2 are summarized in Table 5-1.

Table 5-1 Targets of NRSD2

		Unit	2018/19 (baseline)	Target	
				2025 (mid-term)	2030
1	Area under cultivation	Million ha	1.10	1.43	2.20
2	Yield (paddy)	ton/ha	3.08	4.30	6.15
3	Yield (milled rice)	ton/ha	2.00	3.00	4.00
4	Post-harvest loss	%	30	20	10
5	Harvest	Million ton	2.20	4.29	8.80
6	National consumption (milled rice)	Million ton	1.80	2.60	3.50
7	Surplus	Million ton	0.40	1.70	5.30

Source: NRSD2

5.3.3. Tanzania Agricultural Mechanization Strategy (TAMS)

To contribute to the two national development goals of poverty reduction and economic growth set out in the policies and strategies of the country, such as the Tanzania Development Vision 2025 and ASDP II, Tanzania Agricultural Mechanization Strategy (TAMS) was developed. TAMS sets the direction for development of the mechanization sub-sector. In line with TAMS, the following eight strategic areas of

activity were identified, and a five-year budget of TZS 106.131 billion (5.082 billion yen at the exchange rate of June 2018[162], when the revised draft was prepared) needed to be allocated. Activities in each strategic area are described, but no specific numerical targets are given.

Eight strategic action areas of TAMS
1) Improving access and availability to mechanization inputs
2) Commercializing agriculture through mechanized farming
3) Promoting the development of post-harvest handling, processing, storage, marketing, and rural-based agro-industries
4) Improving livelihoods and land management through conservation agriculture
5) Improving farmers' access to technologies and services
6) Improve financing of agricultural mechanization
7) Improving policies and legal and regulatory environment for agricultural mechanization
8) Managing cross-cutting and cross-sectoral issues

TAMS was developed by the Agricultural Mechanization and Irrigation Division of the Ministry of Agriculture in 2006 and approved in 2009; however, it has not been implemented as yet. As much time has passed since its development, relevant data must be updated for implementation, although this has been delayed due to the lack of resources to collect data.

5.4. Donor support

5.4.1. Support from the Japanese Government including JICA

In 1978, Kilimanjaro regional government launched the Integrated Rural Development Programme with the support of the Japanese government. Under this program, intensive irrigated agriculture development projects were implemented in the Lower Moshi area. Specifically, 2,300 ha of the Lower Moshi Irrigation Scheme was developed with yen loans, and KADC buildings and facilities were constructed with grant aid. As Grant Aid for the Increase of Food Production, 292 tractors and spare parts were provided. As technical cooperation, the KADC project was implemented from 1978 to 1986, followed by the Kilimanjaro Agricultural Development Plan (KADP) (1986-1993), Kilimanjaro Agricultural Technician Training Center Project (1994-2001), and Lowcountry Agricultural Training Center (1994-2001). To date, Kilimanjaro Agricultural Development Plan (KADP) (1986-1993), Kilimanjaro Agricultural Training Center Project (1994-2001), Lower Moshi Integrated Agricultural and Rural Development Plan (1997-1998), Kilimanjaro Agricultural Training Center Project Phase 2 (2001-2006), Technical Cooperation in Supporting Service Delivery Systems of Irrigated Agriculture (TANRICE) (2007-2012) (at five MATI sites, including KATC), and the Project for Supporting Rice Industry Development in Tanzania (TANRICE2) (2012-2019) have been implemented.

(1) Recent JICA projects implemented

As shown in Table 5-2, in recent years, the following projects have been implemented by JICA in the agricultural sector:

[162] Revised draft created in 2018

Table 5-2 Recent JICA projects related to agriculture implemented in Tanzania

Project name	Period	Implementing organization	Outline
Project for Supporting Rice Industry Development (TANRICE 2) (JICA technical cooperation project)	November 2012 to December 2019	Agricultural Training Extension Services and Research Division, Ministry of Agriculture	The project purpose was to have the farmers use rice production technologies in priority rice-producing areas, and the following three Outputs have been set to achieve this goal: Output 1: Training methods (general training) to disseminate appropriate irrigated rice cultivation technologies throughout the country were strengthened. Output 2: Training methods for the dissemination of rainfed rice cultivation technologies were improved. Output 3: Subject-specific training on rice industry value chain was strengthened.
Small Scale Irrigation Development Project (loan project)	Loan agreement signed in May 2013	Ministry of Agriculture, Food Security and cooperatives (at the time)	The purpose of the project was to improve the productivity of agriculture, particularly rice, by constructing irrigation facilities, rehabilitating existing facilities, and procuring related equipment, thereby contributing to improved livelihoods and reduced poverty among small-scale farmers. The total cost of the project was 3.785 billion yen, of which 3.443 billion yen was covered by the yen loan.
Project on the Revision of National Irrigation Master Plan	2016 to 2018	National Irrigation Commission (NIRC)	Over 15 years have passed since the formulation of the National Irrigation Master Plan 2002 (NIMP 2002), and NIRC has approved the project in view of the drastic changes in the irrigation development environment, need to eradicate poverty by improving agricultural income, and increasing demand for sustainable irrigation development. As a result, the National Irrigation Master Plan was revised and an implementation plan was formulated.
Project for Strengthening DADP Planning and Implementation capacity through Use of SHEP Approach (technical cooperation project)	January 2019 to December 2023	Ministry of Agriculture, President's Office, regional administration, and local government	Targeting Arusha, Kilimanjaro, and Tanga Regions, the project aims to establish the SHEP approach (TANSHEP) in Tanzania and to improve the agricultural income of horticultural farmers in the target areas by implementing TANSHEP as one of the district agricultural development plans (DADP) in priority local administrative regions.

Source: Prepared by the survey team based on JICA (2018) Final Report on Project on the Revision of National Irrigation Master Plan, JICA website[163] and interviews with JICA

(2) Planned JICA projects

As shown in Table 5-3, the following projects are planned by JICA in the agricultural sector in Tanzania:

Table 5-3 Planned JICA project related to agriculture in Tanzania

Project name	Period	Outline
Information Collection and Confirmation Survey for Rice Promotion and Strengthening of Extension and	December 2021 to May 2023	The project aims to gather basic information on the rice sector and formulate a project for TANRICE 3 as a follow-up project of TANRICE 2. The project will accept trainees from neighboring countries on a trial basis[164].

[163] JICA website https://www.jica.go.jp/oda/project/TA-P12/index.html
https://www.jica.go.jp/tanzania/office/activities/project/39.html
https://www.jica.go.jp/oda/project/1700376/index.html https://www2.jica.go.jp/ja/announce/pdf/20181003_180325_1_01.pd

[164] From the public announcement of the project

Project name	Period	Outline
Training Systems (TANRICE 2.5)		
Project for Strengthening Capacities of Stakeholders of Rice Industry (TANRICE 3)	From 2023	In addition to the irrigated rice production technologies established and disseminated under TANRICE 2, appropriate rice production technologies will be disseminated to farmers in priority rice production areas throughout the country via training for rainfed rice production technologies and issue-specific training, including good seed production. The project was supposed to start in 2020, but due to procedural issues with the Tanzanian government, it has been delayed and planned to start in 2023.

(3) Grant Aid for the Increase of Food Production/Grant Assistance for Underprivileged Farmers (2KR)

In Tanzania, 2KR were implemented from 1994 to 2001, through which agricultural machinery was provided. The number of agricultural machines provided is shown in Table 5-4. In 1999, over 100 power tillers were provided.

Table 5-4 Machinery introduced in Tanzania through 2KR

	1994	1998	1999	2001	Total
Power tiller		18	146		164
Tractor	5		4	5	14

Source: Prepared by the survey team based on JICA reports on 2KR in Tanzania (from FY1994 to FY2002 and in FY2010)

5.4.2. Supports from other donors

Major support for rice and agriculture by other donors includes the projects listed in Table 5-5.

Table 5-5 Other donors' project in Tanzania

Project name/donor	Period	Outline
Policy and Human Resources Development Fund (PHRD)/World Bank	FY2012	Through PHRD technical cooperation (grant aid with project cost of USD 4.25 million), the project supported the training of 33,000 rice growers in 20 irrigation schemes (15,400 ha). Through this project, agricultural machinery, such as combine harvesters and rice polishing machines, was provided to farmers' groups.

Source: Annual Report of PHRD 2012

5.5. Overview of agricultural mechanization

5.5.1. Current status of agricultural mechanization

Mechanization in Tanzania has been mainly used for upland crop production, with particular use of tractors for land preparation (plowing, harrowing, and leveling),[165] which is highly laborious. Tractors are used not only for land preparation but also for multiple other purposes using various work equipment attached to the front and rear of the machine. According to the Ministry of Agriculture (MoA) officials, along with tractors, the use of machines for processing harvested products in sugar factories and maize flourmills have also advanced.

Tanzania's staple food, maize, is harvested and processed commercially on large farms or at small

[165] Depending on the conditions of the fields, it may be necessary to mow the grass before plowing or to make or coat the bunds; thus, land preparation works cannot be described in one word.

mills in rural areas for farmers' subsistence. The Engelberg machine for primary processing and a hammer-milling machine for maize flour milling mainly in rural areas are already domestically produced, although some parts such as bearings are imported, as confirmed in the preceding survey[166]. In rural areas along with maize mills, rice milling-type machines, often called a one-pass or SB-model rice-milling machine, are installed; therefore, it can also be called rice and flouring mills. A Japanese manufacturer developed the SB model machine, but mostly Chinese imitations are used currently.

The Engelberg (left), and Hammer mill (right) are utilized not only for maize but also for millets, sorghum, and broken rice for use in a flour milling machine.

Photograph 5-6 Processing machinery of maize

Source: Survey team

As mentioned above, rice is emerging as the second major grain after maize production. This survey found that not only tractors were used for rice cultivation, but also power tillers were used in small paddy fields. In small paddy fields in irrigated and rainfed lowland areas, combine harvesters with a harvesting width of approximately 2 m have been widely used for highly efficient and timely harvesting before the establishment of a harvesting system with a reaper and thresher. The following is a description of the use of agricultural machinery in Tanzanian rice-growing areas.

Photograph 5-7 One-pass type rice milling machine at a flour mill of the above Photo 5-6

Source: Survey team

5.5.2. Mechanization situation in rice-growing areas

Tanzania's land area is approximately 2.5 times that of Japan, and rice cultivation is widely practiced throughout the country. Rice cultivation land can be roughly divided into irrigated land, rainfed lowland, and rainfed upland. Irrigated land can produce 2 to 2.5 crops per year, depending on the area, and it is more stable and has higher productivity than that of rainfed areas. This survey was conducted in Bagamoyo and Lekitatu Irrigation Districts located approximately 25 m and 1,200 m above the sea level, respectively, and Mbeya, like Lekitatu, is a highland area, which is the breadbasket of southwestern Tanzania. In high elevation rice-

[166] As mentioned in the preceding survey report, the Engelberg was developed in the United States in the late 19th century as a machine that could be used to peel coffee beans, to grind maize for primary processing (to remove the tip cap and outer skin), and as a rice milling processing machine. In Tanzania and Kenya, broken rice is milled by a hammer mill to make a sweet bread called vitumbua.

growing areas, around July and August, the temperature drops at night, possibly causing damage to rice; however, the temperature rises during the day. This diurnal variation in temperature aids in growing high-quality rice.

(1) Land preparation work

According to the MoA staff in charge of mechanization, power tillers and tractors have been used in many parts of Tanzania for the past 10 years to expand the field area and perform work at the right time. However, in many rice-growing areas, planned work is not being performed. This is because the number of machines is insufficient, and farmers often cannot get service providers at the right time. In most rainfed areas, as the work needs to be done after rainfall, machines are used after the rain. For example, as shown in Photograph 5-8, the soil before rainfall is so hard that even if a disc plow is used, it can only scrape the surface of the field slightly. Therefore, work using agricultural machinery must be done after rainfall[167]. In contrast, it is easier to plan work in irrigated areas, and service providers can prepare for the work in advance. This is because water use plans are usually prepared in irrigated areas. With the help of a tractor, 2-time direct puddling is performed. The service charges using tractors from the interviews in this survey ranged from TZS 230,000 to 330,000 (11,010 to 15,800 yen)/ha. Machinery charges are negotiated between farmers and service providers, depending on the size of the plot, areas, farming season, soil, and water conditions[168].

Photograph 5-8 Dried up soil before rain

Source: Survey team

CASE 70hp

FIELDKING

Photograph 5-9 Tractor and rotary seen in the Lower Moshi Irrigation Scheme

Source: Survey team

In many cases, puddled and leveled conditions are insufficient even when 2-times puddling work is performed in a paddy field by a rotary with a tractor. For this reason, after direct puddling work by the machine,

[167] Rice cultivation in rainfed lowland areas is not necessarily dependent on rainwater and can use a little spring water.

[168] If the number of machines is to increase in the future, the service charge and workability (careful work) will likely change. This is how the principle of competition works. The rice mills described in this report have already secured customers by lowering their prices and adding various services.

farmers work by manually puddling and leveling the field. This is one of the challenges in larger field plots where work efficiency increases, but leveling work becomes difficult. In the Lower Moshi Irrigation Scheme (field plot 100 m × 30 m, 0.3 ha), 2-times direct puddling work is carried out with high field efficiency, and some farmers operate after plowing using a disc plow and then irrigate the field for puddling work. They recognize that a mere 2-times direct puddling work is insufficient for plowing rice straws and pulverizing the soil.

The field was plowed by a 3-disc plow. After this, the field was flooded and puddling was carried out. In this way, the plowing of straw and puddling (pulverizing soil) will be better than direct puddling work.

Photograph 5-10 Plowed field by a 3-disc plow

Source: Survey team

(2) Rice transplanting work

Rice was planted manually by farmers in most irrigated areas and some rainfed lowland areas. They used a string for straight planting. The hill space was approximately 15 cm, and the row distance was 25 cm or less by eye measurement. Rice transplanting work requires considerable workforce, but it is still preferred today despite the high labor costs and difficultly to hire workers. Rice transplanting is often done by hiring workers, although family members and neighbors may cooperate with each other. Labor wages also vary in each area but range from TZS 230,000 to 300,000 (11,010–14,370 yen)/ha.

Inserting a peg into the bund to fix the string for planting.

Photograph 5-11 Manual rice transplanting

Source: Survey team

In some areas, wet direct seeding is practiced; however, because of its rarity, it was not observed during this survey. In the rainfed rice fields of Morogoro District, the tractor is used to harrow with a disc

harrow, spread the seeds (manual broadcasting), and then cover the soil again with a disc harrow. Even in such upland rice areas, harvesting is performed with a combine harvester when the timing and amount of rainfall are favorable. However, according to the mechanization and irrigation division staff, MoA, this is limited to areas where only one crop is harvested per year and the area of rice cultivation is large.

During the preceding survey, an agricultural extension worker in the Mwanza region explained that in the rainfed areas[169] of the Mwanza and Shinyanga regions, south of Lake Victoria, dry direct seeding was being practiced. In this farming method, after rainfall, when the soil is moist enough for plowing, two pairs of oxen are used for plowing with a moldboard plow. Plowing depth is approximately 5 cm and shallow, and soil is full of clods without inversion. Then, sowing was done manually by anticipating the soil and weather conditions, and after sowing, the same two pairs of oxen with the plow were used to cover the soil several times. There is dense and sparse planting; if rainfall is sufficient and the field is flooded, the densely planted plants are pulled out and transplanted to the sparsely planted area.

The rainfed area south of Lake Victoria bears one crop between the short rainy season of November and December and the long rainy season from May to June, and it is difficult to determine when to start work depending on the timing and amount of rainfall in each year. Stable yields are not expected.

(3) Weeding work

Since weeding is mainly done manually, farmers uproot taller weeds, and there is little effect of the fertilizer used on rice. KATC and other extension workers in various areas instruct farmers on weeding approximately 2 to 3 weeks after planting rice, emphasizing the importance of weeding. In tropical paddy fields, high temperatures lead to the rapid decomposition of organic matter in the soil and the production of methane gas[170]. As a countermeasure to this, KATC and MATI recommend the use of hand-push weeders (push weeder: a weeding tool that was also used in Japan) and manual rotary weeders to agitate waterlogged soil. Since hand-push weeders can be made with simple materials and carpentry tools, some farmers make and use their own weeders.

Serrated iron plates are used for scratching the surface of the paddy field and removing weeds, but the wood is thick, therefore there is hand-pushing resistance.

Photograph 5-12 Push Weeder displayed at KATC

Source: Survey team

During the preceding survey, it was confirmed that the Small Industries Development Organization (SIDO) in Moshi City manufactures sells manual rotary weeders on a build-to-order basis.

[169] This refers to rainfed lowland and upland (upland rice), but there are rice-growing areas that cannot be strictly classified. It depends on the rainfall season and the amount of rainfall in that year.

[170] When methane gas is produced, the paddy field smells putrid. Weeding work as an intercultivation field method is important for rice growth, as the soil is agitated by rotary weeders to release methane gas and allow fresh air to enter the soil.

(4) Harvesting work (such as reaping, threshing, and winnowing)

Ordinary combine harvesters[171] with a working width of approximately 2 m are often used in irrigated areas, as reported in the preceding survey. There are no reports of workers engaged in manual harvesting, threshing, and winnowing works losing their jobs because of the use of combine harvesters[172]. This is because there is a shortage of workers supporting agriculture.

The service charge of a combine harvester, such as land preparation by tractor, varies depending on various conditions, ranging from TZS 300,000 to 390,000 (14,370 to 18,680 yen)/ha. The manual harvesting charge is TZS 420,000 (20,0110 yen)/ha or more, and even then, it is not easy to get laborers, as explained by the KATC instructors in charge of agricultural machinery. In the case of manual harvesting, a series of operations including reaping, transporting (collecting harvested paddy at one or two locations in the field), threshing, winnowing, and bagging are performed. However, in some irrigated areas (including the Lower Moshi Irrigation Scheme), the final bagging is not done by laborers but by the farmers (landowners) themselves. This is because the harvesting laborers purposely hide the paddy grains under threshed rice straw when they pack the bags after threshing and winnowing.

The Lower Moshi Irrigation Scheme, attracts many combine harvesters, including those from other regions. This is because each plot is 0.3 ha in size and has good drainage, which allows for efficient work. Service providers try to increase the number of customers for the next crop by offering discounts and careful work when the number of combine harvesters is high. For example, in the Lower Moshi, the average combine harvesting charge is TZS 330,000 (15,800 yen)/ha, but it drops to TZS 300,000 (14,370 yen)/ha when the number of combine harvesters increases.

The combine harvesters used in Tanzania were made by Japanese, Chinese, and Indian manufacturers. In the 2 to 3 years since the preceding survey was conducted, the number of Japanese manufacturer brands began to increase, as explained by farmers, KATC staff, and MoA officials. The reasons are the high threshing accuracy of the combine harvester and low levels of foreign matter such as straw after threshing, almost no breakdowns during operation, good traveling performance even in wetlands with poor drainage, and the high durability of its parts. Japanese manufacturer brands are TZS 20,080,000–31,000,000 (around1,000,000–1,480,000 yen) more expensive than other manufacturer products, depending on the models. The fact that the combine harvesters made by Japanese manufacturers are beginning to be widely used means that although the price is high, the product is recognized as worth the price.

Photograph 5-13 Combine harvester being used in the Mombo Irrigation Scheme

Source: Survey team

The team asked the stakeholders, including farmers, whether Tanzania's many rice fields are small

[171] The popular ordinary combine harvesters are not dedicated to rice alone, but can also be used for wheat, sesame, etc. They can be considered general purpose, but they are used only for rice.

[172] Shimizu. H. (1988) “What is the uniqueness of Japanese agriculture, Summarize the mechanization issue.” Nihon-Keizai-hyouron-sha. In England, during the modernization of agriculture, the spread of the threshers (a throw-in type thresher) led to agricultural workers being out of work, and there were frequent incidents of burning down of threshers.

and require harvesters and threshers other than combine harvesters. Farmers and government officials who had experience in using the machines provided by PHRD (explained later) commented that the performance of the reapers and threshers provided by PHRD was poor, the threshers, in particular, were too heavy to be carried to the field without a tractor, and the cost of using them for harvesting was higher than that of manual labor.

In response to farmers' requests, one of the team members conducted a verification test of PHRD-donated reapers and threshers at KATC. As for the reaper, the reaped paddy plants were discharged to the right side of the machine by a conveying chain, but because the reaping part of the machine is distorted, the reaped paddy plants sometimes fall over before they are discharged from the machine and become stuck. It was unclear whether this was caused by a problem during welding or assembly during the manufacturing processes or whether some impact distorted the machine during transportation. KATC staff were able to repair some of the distortions in the machine but were not able to fix it completely. The thresher was not a machine whose use can be recommended because even if the threshing drum rotation was changed (the peripheral speed of the threshing teeth), paddy grains were discharged from the places where straw was discharged, and the accuracy of separation of the grains and straw was extremely poor. Moreover, according to a farmer's explanation of the cost, in addition to the service charge for the rearing and threshing machines, the labor cost of collecting the reaped paddy plants and transporting them to the threshing site, and bagging the threshed grain, was not worth it.

(5) Drying work

Whether using a combine harvester or threshing manually, bagged paddy grains with high moisture content must be dried immediately. According to farmers in the Lower Moshi and adjacent irrigated areas, some farmers sell undried paddy grains. This is because transporting grain bags from the field to the drying site and drying the grains is a time-consuming process. Some intermediaries are willing to buy undried grains. In such a case, the undried grains must be stirred constantly during sun-drying to prevent cracks formation. Even if farmers dry the paddy grains well, they are broken when the drying process is hastened after milling is completed, the mill is full of broken rice. One of the most common requirements for sun-drying in the tropics is that the thickness of the drying grains should be at least 5 cm, and they should be constantly stirred.

A sheet is spread out in the open space in front of the rice mill, stirring paddy grains.

A concrete drying yard provided free of charge by the rice mill. The thickness of the paddy layer can be seen by the border that prevents it from mixing with another paddy.

Photograph 5-14 Drying yard in front of the rice mill

Source: Survey team

(6) Rice milling processes

As previously mentioned, the Engelberg is rarely used as a rice milling machine. In the report prepared by a JICA expert of crop processing for Kilimanjaro region in 1991, the Engelberg and a hummer mill were used as maize flour milling machines in the Lower Moshi Irrigation Scheme areas and the Engelberg was also used as a rice milling machine. It can be said that in the Lower Moshi area in this report, the Engelberg was used to grind maize (crushing maize grain) for primary processing. However, after the Lower Moshi Irrigation Scheme was developed with the help of Japan, it was also used as a rice milling machine (the Engelberg is more difficult to operate than the one-pass (SB-type) air-jet friction-type whitening machine in terms of adjusting the amount of rice flow and pressure, so it is prone to produce more broken rice). Recently, rice mills in Tanzania have rarely used the Engelberg for rice milling. Although a one-pass (SB-type) machine is used, small rice milling plants that consist of a destoner, a paddy separator that separates paddy grains from brown rice, and a combination of abrasion and friction whitening machines are already being used in many places. In this survey, one such example was found in a rice mill in the Lower Moshi Irrigation Scheme.

The rice mill was established in 2017 and was initially equipped with two one-pass type rice milling machines, but a small new rice milling plant was installed due to a lack of customers, as shown in Photograph 5–15. They consist of a pre-cleaner, destoner, 6-inch rubber roll husker, paddy separator, abrasion whitener, friction whitener, and sizing machine (broken rice separator). The milling charge is based on the weight of white rice. There is a significant difference in the milling charges of paddy grains and white rice. When paddy grain is charged by the weight, the millers do not lose money even if there is a considerable amount of broken rice and milling recovery is low. However, when charging by white rice, even a small increase in the amount of white rice will result in higher sales. Therefore, each machine is carefully adjusted while paying attention to the finish of white rice. The milling charge is TZS 100 (5 yen)/kg of white rice, while the one-pass type milling machine is half the price or TZS 50 (2.5 yen)/kg of white rice.

On the right side are two one-pass type machines

New rice milling plant

Photograph 5-15 Rice mill in the Lower Moshi Irrigation Scheme

Source: Survey team

(7) Transportation work

Transportation is an essential component of farming. Some means of transportation are always necessary, such as for transplanting seedlings from the nursery beds to the fields, transporting paddy grain bags from the fields, and transporting white rice after milling. Haulage using trailers attached to power tillers and tractors is essential for transporting agricultural products and freight, including building materials throughout the year. In Tanzania, lightweight trucks of Japanese and Indian make are increasingly being used.

Lightweight truck carrying rice straw

Power tiller distributing agricultural products to the market.

Photograph 5-16 Vehicle and agricultural machinery used in transport works

Source: Survey team

(8) Price of paddy grain and white rice

As mentioned above, paddy grains are rarely weighed in rice mills. This is because the charge is based on the weight of white rice. The price is per bag when selling dried grain, one bag is therefore converted to kilogram. According to the interviews, the farm gate price of paddy grain is approximately TZS 700–800 (34–38 yen)/kg. The retail price of white rice in Dar es Salaam markets ranged from TZS 1,500–2,500 (72–120 yen)/kg and in supermarkets from 2,750–3,750 (132–180 yen)/kg.

5.5.3. Mechanization of the Mombo Irrigation Scheme

The Mombo Irrigation Scheme in the Tanga region was established in 1979 as an irrigation scheme under the government. The scheme has a gravity irrigation system, with a paddy field area of 220 ha, and 110 ha on each side of the main canal. Water shortages have limited the areas for paddy field plantations, but no severe water shortage has been noted in the past few years; thus, rice can be produced in 1.5 or 2 cropping seasons. One plot of paddy fields was constructed at 100 m × 50 m; however, since the time of establishment until recently, temporary bunds have been made to reduce the size of the plot, for example, two equal parts of 100 m × 50 m (100 m × 25 m) and eight equal parts of 100 m × 50 m (25 m × 25 m). The farmers in Mombo still use temporary bunds to reduce the plots sizes because it is difficult to level the paddy fields in large plot, and there is a relationship with land ownership.

The Mombo Irrigation Scheme was one of the World Bank PHRD assistance recipients in 2012. The machinery provided free of charge includes one reaper (made in China), two tractor-towing type threshers (engine mounted, made in India), one DC60 combine harvester (Kubota, China), one DSC62 head-feeding type combine harvester (Daedong, Korea), and a rice milling plant (made in China, 6-inch rubber rolls, a precleaner, paddy separator, abrasion-type whitening machine, white rice packaging machine with oscillating small rice separator, concrete pavement drying yard (approximately 2,500 m^2), and grain warehouse (750 m^2 floor space)). In 2015 and 2016, these machines were provided, a rice milling plant was installed, and a grain warehouse was constructed. The DC60 combine harvester, rice milling plant, drying area, and grain warehouse were frequently used among the machinery and facilities provided. The DC60 combine harvester has been used not only in the Mombo paddy fields but also as a service provider[173] in the Mbeya region,

[173] Farmers in Mombo are charged slightly less for the use of combine harvesters and rice milling, but as service providers do, they are

approximately 1,000 km away.

As described in the preceding survey report, in 2019, a DC60 (TZS 73 million/3.5 million yen), a New Holland tractor (TZS 50 million/3.5 million yen), and a rice milling plant (TZS 46 million/2.2 million yen) were purchased with a loan from the Tanzania Agricultural Development Bank (TADB) using combine harvesters and sales from the rice mill as collateral. The rice milling plant provided by the PHRD did not have a destoner, and the milling plant has only one-pass abrasion whitening machine, therefore the bran powder did not clean out easily; thus, Mombo purchased an 8-inch rubber roll, destoner, abrasion and friction type milling machines, and sizing machine (broken rice separator). During this survey, in July 2021, 2 years and 4 months after the preceding survey, Mombo purchased two DC70 combine harvesters (Kubota, made in Thailand) and a rice milling plant equivalent to the above with a loan from the TADB. The machinery loan availed in 2019 has been repaid, and the loan for the two units of DC70 and the rice milling plant has been repaid TZS 100 million (approximately 4.79 million yen) that is approximately half of the total loan.

Head-feeding combine harvester provided by PHRD but not used

Reaper and thresher provided by PHRD but not used

Two units of DC60 Combine harvesters

Two units of new DC70 Combine harvesters

Rice mill

Rice milling plant at the back of the photo purchased in 2019 and the one on the right in 2020.

Photograph 5-17 Agricultural machinery owned by Mombo Farmers' Cooperative

Source: Survey team

The service charge for the combine harvester is TZS 260,000 (12,450 yen)/ha within Mombo and approximately TZS 390,000 (18,680 yen)/ha outside of Mombo, based on the fees of other service providers. The milling charge is a flat rate of TZS 60 (3 yen)/kg of white rice. The rice milling plant provided by PHRD is not damaged, but it is hardly used as it has no destoner and is a one-pass abrasion-type whitener with poor bran removal. The newly purchased rice milling plant uses an abrasion type followed by a friction-type whitening machine, therefore the bran is well removed, and the surface of white rice is smooth and shiny; thus, according to the farmers in Mombo, although they have two units of new milling machines, they receive many customers, and the two plants are not sufficient. According to the accountant, the rice milling business

charged based on their area or the amount of white rice they produce. Through JICA's TANRICE2 project, an agricultural machinery management committee has been established to ensure the maintenance of the machinery and the management and guidance of the operators.

is the most profitable business.

Mombo has a 5-year plan for conducting farmers training on inputs such as fertilizer and agrochemicals use, renewal of rice seeds, and machinery operations, and intends to purchase two tractors, two rotaries, two combine harvesters, two rice milling plants, branding rice as Mombo Rice, and expanding the drying yard.

By operating the rice milling machine, they realized the reason for excessively broken rice and that there were issues during the sun-drying process. Currently, many farmers are making efforts to avoid direct sunlight during the daytime and keep the paddy layer thick and constantly stirred. Therefore, the recovery of white rice from paddy grains has increased.

It is important to note that some of the equipment provided by PHRD was not used. When people think of combine harvesters in Japan, they think of the head-feeding type. Japan developed this type, and it was researched and developed for a variety of rice categorized by the difficulty of threshability, which is significant challenge for research and development. It is not suitable for long-grained rice varieties categorized as easily threshable. Even at the precise harvesting time and slow operating speed, the machine can harvest, but the header section of the combine harvester (the section that pulls the rice up to the threshing section after reaping) also vibrates, causing grain losses. If the harvesting season is delayed even a little, the loss will be considerable. As mentioned above, reapers are costly and have poor performance. While other manufacturers' products may be better, the harvested rice will get wet and muddy if they are introduced to a field that is not well-drained at harvest time. The thresher used was heavy enough to be towed by a tractor, and Mombo bought and used a tractor; however, it displayed poor performance. These models could not be adapted to local conditions and should be used as lessons for the future.

5.6. Agriculture inputs (seeds, fertilizers, and agrochemicals)

5.6.1. Seeds

In Tanzania, CS and quality-declared seeds (QDS) are sold as guaranteed quality seeds; however, they are not common among farmers. According to NRDS2, only 15% rice farmers used CS/QDS in 2018/2019. Moreover, according to the Tanzania Official Seed Certification Institute (TOSCI), most rice farmers use their own seeds. In addition to TOSCI, according to TARI, which is in charge of breeding new varieties, and the Agricultural Seed Authority (ASA), which is in charge of disseminating high-quality seeds, the reason for the lack of dissemination of improved seeds is the lack of promotion among farmers.

Photograph 5-18 CS (SARO5) sold by ASA

Source: Photographed by the survey team

Tanzanian seed is classified as BS, pre-basic seed (PBS), basic seed (BAS), CS, and QDS. BS and PBS production is managed by TARI, which has centers in 17 locations. TARI Dakawa and Ifakara produce BS and PBS for rice[174]. In addition to TARI, BAS and CS are produced and sold to farmers by ASA and

[174] ASA produced respectively 987 and 900 tons of improved seeds in 2017 and 2018 (NRDS2)

private seed companies[175]. QDS is produced by farmers or farmer groups registered and trained by TOSCI. They produce QDS using PBS, BAS, or CS (1st generation)[176]. Private seed companies do not produce QDS. According to TARI Dakawa, QDS (rice) is sold at TZS 1,500/kg, which is cheaper than CS. However, while CS can be sold nationwide, QDS sale is limited within the district. In addition, individual farmers can produce rice using QDS in 5 acres (2 ha) per farmer and farmer groups in 12 acres (4.8 ha) per group.

According to NRDS2, the common rice varieties grown in Tanzania are TXD306 (SARO5) and Supa. SARO5 is a variety developed by TARI Dakawa[177].

If an overseas company wants to start a seed business in Tanzania, in addition to the regular company registration, the company must register with TOSCI. They can register online, but at least one person from the registered company must complete the training course conducted by TOSCI (the fee is TZS 150,000 for a 3-day training course).

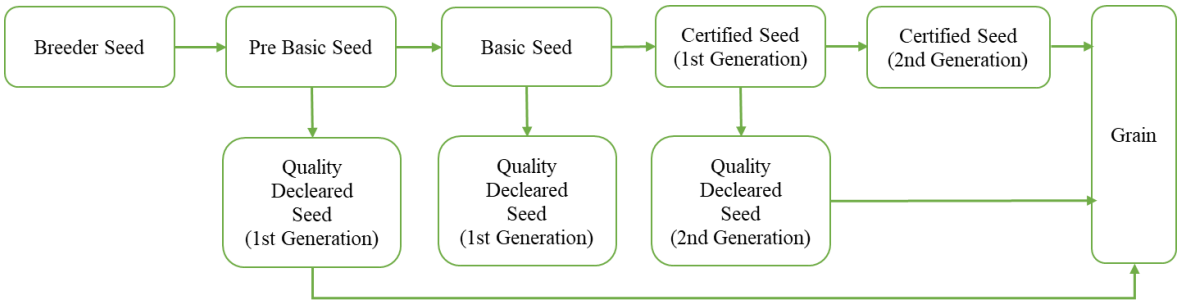


Figure 5-10 Categorization of seeds

Source: Prepared by the survey team based on the interviews with TARI Dakawa, ASA, TOSC, and KATC

5.6.2. Chemical fertilizers

Only around 15% of rice farmers use fertilizer due to the high selling price and unavailability of fertilizers at the time of application.

According to rice farmers, fertilizer dealers, and organizations related to rice cultivation (KATC, TARI Dakawa, and others), the commonly used fertilizers for rice production are DAP, urea, and NPK17-17-17. According to the Lekitatu Irrigation Scheme and the Export Trading Group Inputs Tanzania (ETG Inputs), DAP and urea are used as base and additional fertilizer, respectively, or alternatively NPK17-17-17 is used.

The Bulk Procurement System (BPS) was launched in 2017 after the completion of the National Agricultural Input Voucher Scheme[178] in 2016/2017. Under this system, the Tanzania Fertilizer Regulatory Authority (TFRA)[179] was in charge of procuring fertilizers and controlling their selling price in Tanzania.

[175] The selling price of rice BAS and CS by ASA is TZS 4,000/kg and TZS 2,500/kg, respectively.
[176] QDS production in 2018 was 500 tons (NRDS2).
[177] SARO5 yield is 4.0–6.5 tons, and it requires 100–102 days to maturity; Supa yield is 1.5–3.5 tons, and it requires 93–100 days to maturity [TOSCI (2020) List of Registered Seed Varieties].
[178] The National Agricultural Input Voucher Scheme was implemented by the Tanzanian government and was designed to respond to the rising global grain and fertilizer prices. (WB (2014) Tanzania Public Expenditure Review: National Agricultural Input Voucher Scheme).
[179] It is a public institution under MOA that was established in May 2012 to regulate the manufacture, import, sale, and use of fertilizers in Tanzania.

During the implementation of BPS, the maximum selling prices of DAP and urea were set in each region[180]. However, due to the high fertilizer prices, BPS maintenance was difficult, and the government procurement for 2021 was canceled. Therefore, as of July 2021, fertilizer distributors were free to set their own fertilizer prices. According to JAMA Agro Services, a fertilizer retailer in Arusha stated that fertilizer prices have increased due to the abolition of BPS[181]. For instance, the price of urea sold at JAMA Agro Services was TZS 55,000 per 50 kg in 2020 but increased to TZS 75,000 per 50 kg in 2021. Similarly, the price of DAP increased from TZS 65,000 to TZS 85,000 per 50 kg.

Photograph 5-19 Urea sold by ETG Inputs

Source: Photographed by the survey team

TFRA is responsible for the registration of fertilizers and fertilizer manufacturers, blenders, importers, and distributors. Fertilizers and fertilizer companies can be registered online[182]. Fertilizers can be analyzed at TARI Mlingano (chemical fertilizer), Sokoine University of Agriculture (chemical and organic fertilizers), and others. As of July 2021, TFRA planned to open a laboratory to conduct fertilizer analysis for registration. However, applicants who do not reside in Tanzania cannot register their fertilizer products; thus, foreign companies entering the fertilizer business must cooperate with local agents[183].

5.6.3. Organic fertilizers

The Tanzanian government promotes organic farming and use of organic fertilizers[184]. The Tanzania Organic Agriculture Movement (TOAM), an NGO that promotes organic farming, is involved in the preparation of the Organic Agriculture Strategy. Guavy[185] manufactures and sells organic fertilizers, although they are not widely used.

According to KATC and TOAM, farmers use animal manure, such as chicken and cow manure, as organic fertilizers. Farmers in the Lekitatu Irrigation Scheme apply chicken manure during the cropping season and cow manure before the harvesting season.

5.6.4. Agrochemicals

In Tanzania, various agrochemicals, including herbicides and insecticides, are sold in the market. Agrochemicals used for rice cultivation sold in Morogoro are listed in Table 5-6.

Table 5-6 Types, wholesale prices, and sellers of agrochemicals in Morogoro

Type	Name	Wholesale price (TZS)	Company
Insecticide	DARSFARM 240EC	14,500/L	Farmbase
Insecticide	FIPROFARM 50SC	5,200/100 mL	Farmbase

[180] For instance, as of November 30, 2020, the wholesale price in Morogoro was capped at TZS 67,717 per 50 kg for DAP and TZS 47,789 per 50 kg for urea [TFRA (2020) FIP DAP wholesale, TFRA (2020) FIP Urea wholesale].

[181] According to ETG Inputs, fertilizer prices increased due to taxes, such as port entry tax, once government intervention through BPS was removed.

[182] TFRA website (http://fis.tfra.go.tz/)

[183] TFRA (2020) Fertilizer Register Book for Registered Fertilizers and Fertilizers Supplements, TFRA

[184] ASDP II

[185] A company that manufactures and sells organic fertilizers commercially in Tanzania. Food wastes and other natural materials are used as raw materials for organic fertilizers (https://www.facebook.com/guavay/).

Type	Name	Wholesale price (TZS)	Company
Insecticide	NOGOZONE 60EC	4,000/100 mL	Farmbase
Selective herbicide	GUGUZOT 200 SL	11,000/L	Farmbase
Selective herbicide	FARMBASE2,4-D, AMINE 720 SL	8,500/L	Farmbase
Non-selective herbicide	RICE BUG	20 mL: NA	Farmbase
Non-selective herbicide	GLYPHOCEL 480SL	9,000/L	ETG Inputs
Non-selective herbicide	PARQUICK	8.000/L	ETG Inputs
Selective herbicide	FALCON 24D 72%SL	9,000/L	ETG Inputs
Selective herbicide	PENDALIN	20,000/L	ETG Inputs

Source: Prepared by the survey team on the document provided by ETG Inputs and Farmbase

The Tropical Pesticides Research Institute is in charge of pesticide registration. The registration process varies according to the cultivation period of the crop; however, it normally takes at least 6 months from application to registration. The National Biological Control Center under the MOA is in charge of the registration of biological pesticides until the documents are checked and verification tests are done, and the Tropical Pesticide Research Institute is in charge of the rest of the process.

5.7. Advanced agricultural technologies

5.7.1. Drones

There are several examples of local drones in the agricultural sector.

For instance, Tanzania Flying Lab [186] conducted training on drone operations for KATC, Lower Moshi Irrigation Scheme, and Arusha Technical College. A Tanzanian start-up company, Agrinfo, has partnered with Tanzania Flying Lab to analyze crop growth using field data obtained from drones. However, according to Tanzania Flying Lab, drone services in the Tanzanian agricultural sector remain at the "experimental stage" and have not been applied practically as yet.

Photograph 5-20 Drone for spraying fertilizer by J-EGRO TECH

Source: Photographed by the survey team

In addition, the Sokoine University of Agriculture has conducted a drone project for agriculture with the University of Maryland, USA. Moreover, this university is planning to introduce a drone-operated spraying machine under the "Higher Education for Economic Transformation" project[187] supported by WB. J-EGRO TECH provides pesticide spraying services to farmers for USD 20–25 per acre. However, a representative from the Sokoine University of Agriculture pointed out that it is difficult to comment on the use of drones in the agricultural sector in Tanzania at the moment.

[186] A member of WeRobotics (https://werobotics.org/), a non-profit organization registered in the USA
[187] Tanzania Commission for Universities Website (https://www.tcu.go.tz/?q=content/heet-documents)

5.7.2. Agricultural applications and farming support system

In Tanzania, the government operates Mobile Kilimo[188] under the United Nations Development Programme (UNDP). Mobile Kilimo is a system that allows agricultural extension officers to efficiently give technical advice to farmers. Moreover, in the future, farmers will be able to buy and sell agricultural equipment and inputs through Mobile Kilimo.

Photograph 5-21 Vegetation index map by Jembe Kilimo

Source: Agrinfo (2021) Jembe Kilimo Training Manual

Agrinfo has developed a farming support system called "Jembe Kilimo." This system analyzes the growth status of crops based on field data obtained using drones and creates a vegetation index map (Photograph 5-21)[189]. Based on this map, agricultural extension officers provide advice to farmers through SMS[190]. During this survey, they were conducting a verification test in the Lower Moshi Irrigation Scheme. Data from over 200 fields in this irrigation scheme will be analyzed, allowing agricultural extension officers to provide advice to over 100 farmers.

5.8. Access to finance

5.8.1. Government finance institutions

(1) Tanzania Agricultural Development Bank (TADB)

TADB is a government finance institution established to promote development of the Tanzanian agricultural sector. The bank has four branches in Tanzania and provides loans to small and medium enterprises, farmers' cooperatives, and small-scale farmers, with the total loan amount of approximately TZS 225.8 billion (10.8 billion yen) provided to 1.7 million customers by the second quarter of 2020. In terms of loan amount by target crop, coffee accounts for 38%, cashew nuts for 22%, maize for 8%, cotton for 6%, and beef for 4%, with cash crops accounting for the major share. The major financing schemes for the purchase of agricultural equipment and materials are shown in Table 5-7.

Table 5-7 Major loan schemes for the purchase of agricultural materials and equipment (TADB)

Name of service	Purpose	Target	Loan Amount	Repayment period
Asset Financing	Purchase of tractors, planters, harvesters, and irrigation equipment	Farmers' unions, labor unions, and small businesses	Less than 75% of the acquisition cost of the asset	1 year
Project Financing	Land preparation and purchase of agricultural materials and livestock	Farmers' associations, small and medium enterprises, brokers, livestock farmers, and fishermen's associations	Less than 75% of the acquisition cost of the asset	1~15 years (A grace period of up to 2 years may be granted)

Source: Compiled by the research team based on the TADB website (https://www.tadb.co.tz/business)

[188] Mobile Kilimo was first introduced in June 2014 in Bunda district and later in Ileje and Kilosa districts; it was redesigned to allow farmers to access markets and farming services using their cell phones between 2018 and 2021. (https://esrf.or.tz/index.php/knowledge-management/).

[189] Vegetation index is a measure of plant health. A typical vegetation index is the Normalized Difference Vegetation Index (NDVI) (https://www.gsi.go.jp/kankyochiri/ndvi.html).

[190] A function to connect farmers with agricultural service providers (e.g., agricultural input suppliers and finance institutions) is also implemented.

(2) Agricultural Inputs Trust Fund (AGITF)

AGITF is a governmental agricultural finance fund established in 1994. It provides loans to farmers for the purchase of agricultural machinery, such as tractors, work equipment, tillers, and combine harvesters, and has financed the purchase of 1,250 tractors between 2003 and 2021 (20 tractors in 2019/2020 and 23 tractors in 2020/2021). Interest rates are 7% per annum for individual farmers, 6% for farmer groups, and 8% for agricultural input wholesalers, with repayment periods varying depending on the loan target.

5.8.2. Private financial institutions

(1) Commercial banks

There are 37 commercial banks in the country that have obtained operating licenses from the Central Bank of Tanzania. Among them, CRDB is responsible for nearly 40% of the total agricultural loans in Tanzania, and it is one of the banks that focus on financing agricultural equipment and materials. The agricultural sector loans in 2020 were TZS 518.6 billion (24.8 billion yen), over 90% of which targeted large or small- and medium-sized enterprises. CRDB offers a Kilimo Loan to finance the purchase of agricultural inputs to commercial farmers and farmer groups and an Asset Loan to finance the purchase of agricultural machinery to small farmers. Interest rates range from 14% to 20% per annual, with a repayment period of 3 years.

In addition to CRDB, several other commercial banks provide loans for the purchase of agricultural equipment and materials. In this survey, interview was conducted to major commercial banks, that were exhibiting at an international trade fair in Tanzania, regarding their financing for the purchase of agricultural materials and equipment. The details of each bank's financing are shown in Table 5-8.

Table 5-8 Major Loans for the purchase of agricultural materials and equipment (commercial banks)

NMB Ltd. (NMB)	➢ Loan scheme name: Investment Loan ➢ Eligibility: Farmers owning 15 acres or more of land, farmer groups, and corporations ➢ Use of loan: Purchase of tractors, tillers, and combine harvesters, among other equipment ➢ Annual interest rate: 16–17% ➢ Repayment period: 3 years ➢ Repayment rate: 80%
National Bank of Commerce (NBC) Ltd. Tanzania	➢ Loan scheme name: Terms Loan ➢ Eligibility: Individuals and corporations with at least 3 years of experience in the agriculture, livestock, and fisheries industries ➢ Use of loan: Purchase of agricultural machinery (e.g., tractors) and agricultural inputs or construction of warehouses ➢ Annual interest rate: 16–22% ➢ Repayment period: 3 years ➢ Repayment rate: 90–95%
Equity Bank Tanzania Limited	➢ Loan scheme name: Equipment Loan ➢ Eligibility: Farmers with 2–3 acres of land, agricultural cooperatives, and corporations ➢ Use of loan: Purchase of agricultural machinery and wage farming services ➢ Annual interest rate: 13% ➢ Repayment period: 3 years

Source: Compiled by the survey team based on the results of interviews with each financial institution

(2) Microfinance banks

There are five MFBs in the country that are licensed to operate by the Central Bank of Tanzania. Among these, FINCA Microfinance Bank was the first to receive a license.

FINCA Microfinance Bank partnered with TADB to provide agricultural loans until around 2019. Loans to small businesses could be used for the purchase of agricultural equipment and materials. Only around 20% of the total number of customers received business loans for agriculture as the primary purpose of the loans.

Victoria Finance PLC (VFP) is a non-depository MFB established in 2009 with branches in Mbeya and Dakawa. According to VFP, it is the only MFB in the country that provides loans for rice production purposes within agriculture. In addition to business loans to small and medium enterprises, VFP has started agricultural lending in 2016, with 40% of its loans in FY2020 provided to the agricultural sector and 60% to other businesses. However, it aims to increase the share of agricultural lending to 70% by 2023 given the potential of agriculture. Among agricultural loans, Micro Leasing is mainly targeted at small-scale farmers who produce rice and can be used to purchase agricultural machinery. The loan amount ranges from TZS 5–20 million (24–96 million yen); the interest rate is 36%, and the repayment period is 2 years. The purchased machinery (power tillers or small pumps) is used as collateral. The loan amount for agricultural machinery for rice production was USD 50,000 (5.53 million yen for 9 units of power tillers) in 2019. In 2020, however, only poultry farming equipment (11 units) was provided, and no loans were offered for agricultural machinery.

(3) Savings and credit cooperative societies (SACCOS)

There are 1,505 SACCOS operating in Tanzania. Among them, the ELCT ND SACCOS in Moshi is the largest in northern Tanzania. In July 2021, it had 5,145 male members, 4,902 female members, and 502 corporations, such as agricultural corporations. To join an SACCOS, one must be at least 18 years of age and pay at least TZS 300,000 (14,370 yen) in capital upon joining. After joining the SACCOS, one can use a savings account (Deposit), a saving account (Saving), or a loan (Loan), with the maximum loan amount being three times the deposit amount. Equipment Loan, which can be used for the purchase of agricultural machinery, has the loan amount of TZS 1–40 million (47,890–1,915,600 yen). The interest rate is 1.1% per month, 13 % per year, or 25% (2 years) depending on the repayment period.

(4) Leasing companies

1) EFTA Ltd.

EFTA Ltd. (EFTA) is a construction and agricultural machinery leasing company that receives loans from commercial banks and international organizations to purchase machinery from suppliers and leases the machinery to customers. Agricultural machinery accounts for 40% of the total machinery leased (50% if machinery for transporting crops is included) and includes tractors, combine harvesters, power tillers, rice millers, and food processing equipment. Nearly 70% of agricultural machinery is made by New Holland and the rest is made by Kubota and Swaraj. Tractors accounted for nearly 76% and combine harvesters for nearly 19% of the total farm machinery leased from 2020 to July 2021. The share of Japanese tractors leased in the total was small, because Japanese brand tractors were not leased as of July 2021. Regarding combine harvesters, most of the leased combine harvesters were of Japanese brands owing to their high durability. The interest rate is 31% per year. First, the customer makes a down payment of 25% of the machine's price and then pays the rest as lease payment over the next 1–3 years. After the payment is completed, the customer can

take possession of the machine. In order for Japanese agricultural machinery to be included in EFTA's leasing program, first a local agent or local base must be set up to locally procure the machinery and spare parts. When setting up a distributor, a maintenance and repair system must be established for the machinery and local technicians must be trained.

2) Private Agricultural Sector Support (PASS) Trust

The PASS Trust is a fund established in 2000 through the Business Sector Program Support III implemented by the Tanzanian and Danish governments. PASS includes the PASS Trust, which provides guarantee to financial institutions for providing loans to farmers, and the PASS Leasing Co. Ltd. If the amount the bank has loaned to a farmer, either through an agricultural corporation or directly, is not repaid by the borrower, the PASS Trust compensates the bank for the loss. The PASS Trust then charges 60% of the amount due to the bank to the Swedish government as a re-guarantee and 40% to the Danish government. PASS Leasing Co. Ltd. purchases equipment from suppliers and leases it to farmers. At the beginning, 20% of the price of the equipment is paid as a down payment and the remaining 80% is paid in installments over the next 1–3 years. In some cases, the lease period for expensive farm machinery, such as tractors, is set to 4 years or longer. After the full payment is made, the farm equipment becomes the property of the farmer.

5.9. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team:

5.9.1. Basic policy for the establishment of AFICAT (draft)

As of July 2021, when the field survey was conducted in Tanzania, activities in Tanzania were restricted to Dar es Salaam, areas within an 8-hour drive from Dar es Salaam, and Arusha Region due to the effects of COVID-19. AFICAT activities are planned to initiate at KATC and the Lower Moshi Irrigation Scheme because JICA experts can visit these areas even under such circumstances; these areas are relatively close to the international airport; Japan has been supporting irrigation, rice cultivation, and field cropping in the Lower Moshi Irrigation Scheme since the 1970s; and technical cooperation projects based at KATC in the agricultural sector have been planned in the future. After the AFICAT project is launched, the scope of activities will be expanded to other MATIs and sites depending on the interest of Japanese companies and ease of restrictions on movement due to COVID-19. From the Tanzanian government, Agricultural Training and Extension Services and Research Division of Ministry of Agriculture, which is in charge of KATC, and Agricultural Mechanization and Irrigation Division, which is in charge of agricultural mechanization, will be the collaborating organizations.

5.9.2. Candidate institutions/locations/schemes for collaboration with AFICAT (draft)

(1) KATC and Lower Moshi Irrigation Scheme

As mentioned above, the Agricultural Mechanization and Irrigation Division and the Agricultural Training and Extension Services and Research Division of the Ministry of Agriculture will be the collaborating organizations and activities will start at KATC and the surrounding Lower Moshi Irrigation Scheme, where resources such as buildings, agricultural machinery, personnel, and fields are available to some

extent. AFICAT will also collaborate with CAMARTEC, which is responsible for the inspection and certification of agricultural machinery, as required. CAMARTEC is under the Ministry of Industry, Trade and Investment and according to interviews with both CAMARTEC and the Agricultural Mechanization and Irrigation Division of the Ministry of Agriculture, both organizations cooperate with each other as required. However, since the ministries are different, depending on the nature of the collaboration, a letter requesting collaboration must be submitted by the Ministry of Agriculture at the time AFICAT activities are initiated.

In case research and development of new technologies are essential, collaboration with the Sokoine University of Agriculture, the largest agricultural university in Tanzania, and Tanzania Agricultural Research Institutes (TARI), a research institute under the Ministry of Agriculture, will be considered.

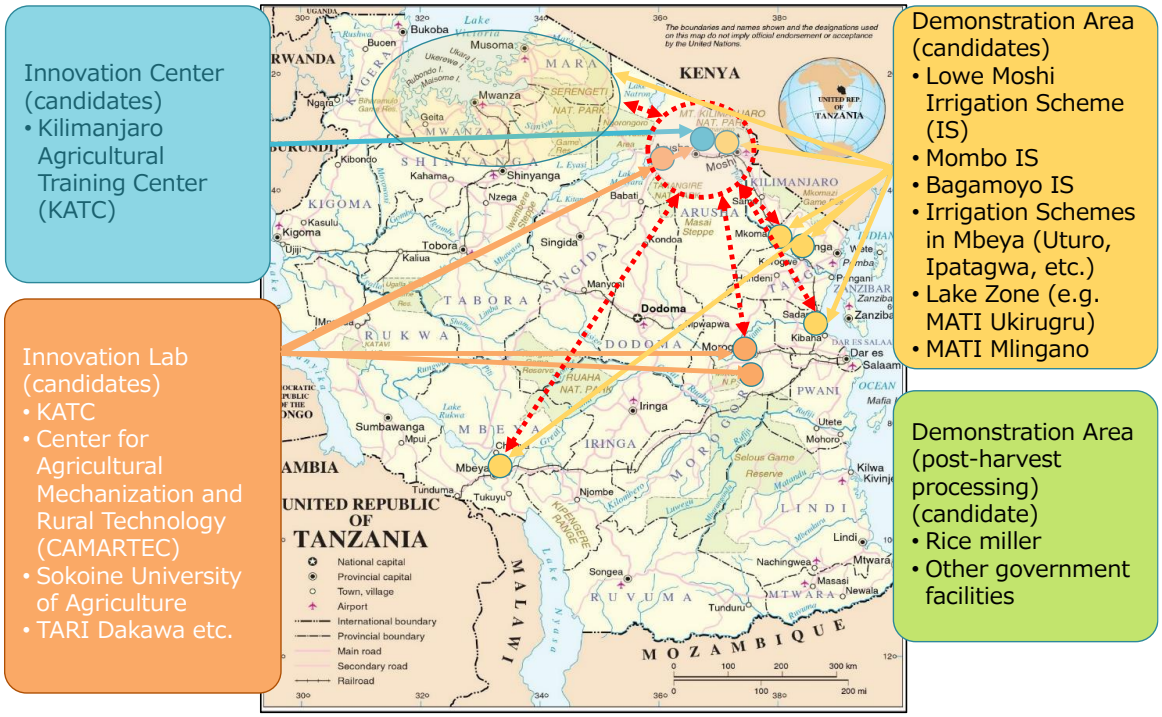


Figure 5-11 Candidate institutions/locations/schemes for collaboration with AFICAT (draft)

(2) KATC rehabilitation to activate AFICAT functions

KATC was built in 1981 with the cooperation of Japan. As described below, KATC has a wide range of facilities, including staff rooms for training instructors, lecture rooms, seminar rooms, laboratories, lodging, workshops for agricultural machinery and equipment, maintenance rooms (with various tools and machines), machine sheds, irrigated plots, and upland fields for crops, including horticultural crops. In addition to technical guidance for KATC and MATI training instructors, activities and consultations on agricultural machinery utilization have been regularly conducted in cooperation with CAMARTEC and SIDO, as reported in the preceding survey[191]. Thus, KATC is expected to start AFICAT functions at the earliest. However, since the facility was built nearly 40 years ago, it needs to be repaired in various areas and the agricultural equipment storage area needs to be expanded when AFICAT activities start. The estimated cost of rehabilitation provided by KATC is approximately TZS 74 million (3.54 million yen), as shown in Table 5-9.

[191] CAMARTEC is responsible for the inspection and verification testing of agricultural machinery, but unlike KATC, it does not have paddy fields or farmland in its facilities.

Table 5-9 Estimated cost for the rehabilitation of KATC facilities

Estimated Cost for Rehabilitation of KATC Facilities

DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1. KATC Buildings: Offices, Workshops and Wearhouse				
Weather guard (Cream paint)	buckets	10	160,000	1,600,000
Weather guard (Dark grey paint)	buckets	10	160,000	1,600,000
Undercoat (Binder)	buckets	2	160,000	320,000
Black bituminous paint	Tins	10	35,000	350,000
Clear polish	Tins	5	35,000	175,000
White Weather guard	bucket	16	40,000	640,000
Emulsion paint/Rangi ya Maji	buckets	60	40,000	2,400,000
SILK Primer	buckets	10	160,000	1,600,000
GALAXY PAINT-White	buckets	25	160,000	4,000,000
Gypsum powder	bags	5	25,000	125,000
White Cement(Wall putty)	bags	10	45,000	450,000
Sand papers (No. 120)	roll	4	45,000	180,000
Brush wire	pcs	12	6,000	72,000
Brushes 5"	pcs	12	5,500	66,000
Brushes 4"	pcs	8	4,500	36,000
Brushes 2"	pcs	8	2,500	20,000
Brushes 1"	pcs	3	2,000	6,000
Scrapper 4"	pcs	8	3,500	28,000
Scrapper 2"	pcs	2	3,000	6,000
Painting rollers	pcs	28	9,000	252,000
Sand papers (no. 120)	roll	4	45,000	180,000
9mm Thick G/board	pcs	20	25,000	500,000
Solvent	gallons	6	30,000	180,000
Transport cost	Lump sum			350,000
Labour charges	Lump sum			9,000,000
			SUB TOTAL 1	**24,136,000**
			Converted to yen, 1	**1,155,870**

2. Agricultural Machinery Shed				
Sheet plate 20 gauge	20	pcs	110,000	2,200,000
Square pipe 1"x1"	120	pcs	24,500	2,940,000
Square pipe 2"x2"	40	pcs	47,800	1,912,000
Flat bar 1.5" 4mm	18	pcs	25,000	450,000
Bush 2"	18	pair	6,000	108,000
Black pipe class B 6mm	15	pcs	250,000	3,750,000
Wire mesh	25	pcs	25,000	625,000
Cutting disk	20	pcs	15,000	300,000
Granding disk	10	pcs	18,500	185,000
Red oxide	15	Tins	12,000	180,000
Iron sheet for rofing (Corrugated panel)	55	pcs	49,500	2,722,500
Nail for sheets 3"	20	kg	22,000	440,000
Bolts and nuts 16 mm	40	kg	28,000	1,120,000
Nail 4"	20	kg	10,000	200,000
Nail 3"	25	kg	10,000	250,000
Concrete nails	20	box	12,000	240,000
2x10 hardwood	3	M3	650,000	1,950,000
4x4 hardwood	2	M3	600,000	1,200,000
2x2 hard wood	2	M3	550,000	1,100,000
1x10 hardwood for fascial board	1	M3	550,000	550,000
Cement	120	bags	16,000	1,920,000
Sand	30	m3	68,000	2,040,000
Agregates	10	m3	350,000	3,500,000
Binding wire 6mm	10	kg	4,000	40,000
Angle channel	6	pcs	30,000	180,000
Blocks	1,200	pcs	1,600	1,920,000
Transport cost		Lump sum		350,000
Labour charges for Welding		Lump sum		4,800,000
Labour charges for Masonry		Lump sum		2,600,000
Labour charges for Roofing		Lump sum		1,500,000
			SUB TOTAL 2	**41,272,500**
			Converted to yen, 2	**1,976,540**
3. Sanitary Accessaories				
WC Suite	1	pcs	320,000	320,000
Floor tiles 30x30	1	box	450,000	450,000
Grouts	5	pact	4,000	20,000
Pure pine Cleaner	10	lts	120,000	1,200,000
Transport cost		Lump sum		120,000
Labour charges		Lump sum		1,800,000
			SUB TOTAL 3	**3,910,000**
			Converted to yen, 3	**187,250**
4. Supervision Allowance				
Allowance for 3 supervisors	50	days	90,000	4,500,000
			SUB TOTAL 4	**4,500,000**
			Converted to yen, 4	**215,510**
			Ground Total 1 to 4	**73,818,500**
			Converted to yen, 1 to 4	**3,535,170**

5.9.3. Proposed seven functions of AFICAT

As mentioned above, AFICAT will establish an operational structure in KATC and the Lower Moshi Irrigation Scheme as a base for exhibition, verification, and demonstration. The seven functions of AFICAT that can be implemented in and around KATC and their contents are summarized below. Among the seven functions of AFICAT, priority will be given to (1) advice; (2, 3) exhibition, verification, and demonstration of products as well as business model and value chain; and (6) public relations, and specific plans will be formulated based on the intentions of Japanese companies.

- ✓ Function 1: Advice
  - Technical advice from Japanese experts to CPs
  - Policy recommendations to the Tanzanian government through the verification of agricultural machinery and value chains
  - Provision of relevant information to Japanese companies
- ✓ Functions 2 and 3: Exhibition, verification, and demonstration
  - Exhibition of agricultural machines at KATC and other organizations
  - Involvement of students and lecturers studying at MATIs other than KATC in exhibitions, verifications, and demonstrations at KATC
  - Verification and demonstration of agricultural machinery using farmers' fields and demonstration plots (tractors, combine harvesters, various implement, power tillers, including small ones, sluice gate management systems, and sensing technology)
  - Introduction of rice-mill-related equipment in cooperation with local rice mills to improve the quality of locally produced rice and demonstration of locally produced rice value chain (rice milling facilities, stone removal machines, moisture meters, rice husk grinding, and solidification equipment)
- ✓ Function 4: Finance
  - Development of leasing and financing schemes for agricultural machinery in cooperation with financial institutions after verifying the profitability of agricultural machinery
  - Dissemination of information on financial schemes available for farmers to purchase agricultural machinery to Japanese manufacturers
  - Demonstration of agricultural machinery in cooperation with banks, leasing companies, and other financial institutions (demonstration of Japanese companies' products at briefings and events for financial institutions' customers).
- ✓ Function 5: Innovation lab
  - Inspection and demonstration of agricultural machinery in cooperation with CAMARTEC, and identification of items for improvement
  - Collaboration with educational institutions, such as the Sokoine University of Agriculture and TARI, on research and development of new technologies, and joint research and demonstration to promote the use of agricultural machinery
- ✓ Function 6: Public relations
  - Information on the performance and efficiency of Japanese agricultural machinery already introduced in the field, results of demonstrations of newly introduced agricultural machinery, plans

and results of demonstrations will be collected and actively publicized if the Japanese companies have consented.

- ✓ Function 7: Human resource development
  - Training of instructors and students in KATC and other MATIs
  - Training of operators and mechanics in collaboration with agricultural machinery dealers
  - Training of agricultural machinery operators in the Lower Moshi Irrigation Scheme and other irrigation schemes in Tanzania
  - Training of officials from neighboring countries in cooperation with JICA subject-specific training PAMA[192] and third country training from other countries (in an effort to expand AFICAT activities to neighboring countries, AFICAT will cooperate with JICA training projects and TANRICE 2.5)

5.9.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

- ✓ Agricultural machinery
  - In Tanzania and other countries, the price of Japanese agricultural machinery manufacturers' products is generally higher than that of machinery made in other countries, such as China and India. However, this and past surveys and projects in Tanzania have confirmed that the buyers of agricultural machinery do not necessarily select models based on price alone. For instance, a cooperative in Mombo Irrigation Scheme has been purchasing Japanese products, even though these products are more expensive than those made in other countries, because they realized that the Japanese products are superior in terms of performance, durability, and part supply. In one case, a SACCOS provided loans to small-scale member farmers for inexpensive Chinese power tillers, which broke down so often that the SACCOS was unable to collect the loans and they had to restrict loans for Chinese equipment[193]. In order for the value of the product to be commensurate with the price, the correct use of the product must be demonstrated by instructing its proper use for a certain period and monitoring the operation status. AFICAT is expected to compile such successful cases to provide information, demonstrations, and publicity in Tanzania.
  - The next issue to be addressed is effortless and prompt supply of parts, including after-sales services. This is not an easy task for Japanese manufacturers. For users, the lack of availability of parts is a fatal flaw to promote agricultural mechanization. AFICAT will monitor the use of Japanese products to the extent possible, liaise with Japanese companies and local agents, and provide necessary advice to ensure prompt supply of parts and appropriate after-sales services.
  - Although the use of agricultural machinery, particularly in irrigated areas, is increasing, the extent remains small, and there is much room for mechanization in the future. Combine harvesters made by Japanese manufacturers (standard type with a cutting width of around 2 meters) are becoming popular, and combine harvesters are being used even in small plots of 0.1 ha.
  - Some farmers (in the Mombo Irrigation Scheme) have expressed interest in rice planting machines;

[192] JICA Tsukuba implemented a project-specific training program called "Promotion of Agricultural Mechanization for Africa (PAMA)" from FY2019 to FY2021. Similar training for 3 years starting from FY2022 is under planning, and the use of KATC and other institutions, in addition to Japan, is being considered.

[193] JICA (2015) JICA Preparatory Survey on BOP business on Rental Service and Credit Sales of Agricultural Machinery in Tanzania.

however, AFICAT must carefully examine whether these machines can be used under Tanzanian conditions and whether the business of rice planting service provision can succeed.

- Government subsidies for agricultural machinery have not been identified, but the import of agricultural machinery is exempted from taxation. There are guarantee institutions for agriculture-related loans, and an environment is being created that will make it easier for financial institutions to provide loans to the agricultural sector. The number of institutions offering leases for agricultural machinery is also increasing, promoting agricultural mechanization in Tanzania.

Chapter 6. Current Status of and Issues Related to Agricultural Mechanization in Cote d'Ivoire

6.1. Outline of the agriculture sector

6.1.1. Agriculture overall

Agriculture is a major industry in Cote d'Ivoire, accounting for 40% of the workforce and 21% of GDP[194]. The production of food crops in 2019 was as follows: 7.18 million tons of yams, 5.24 million tons of cassava, 2.18 million tons of cocoa beans, 1.97 million tons of sugarcane, 1.88 million tons of rice (paddy), and 0.79 million tons of cashew nuts (in shell)[195]. Cote d'Ivoire is world's largest producer of cacao beans and cashew nuts (in shell). In particular, cocoa bean production in Cote d'Ivoire is nearly three times that in Ghana (810,000 tons), which the world's second largest producer.

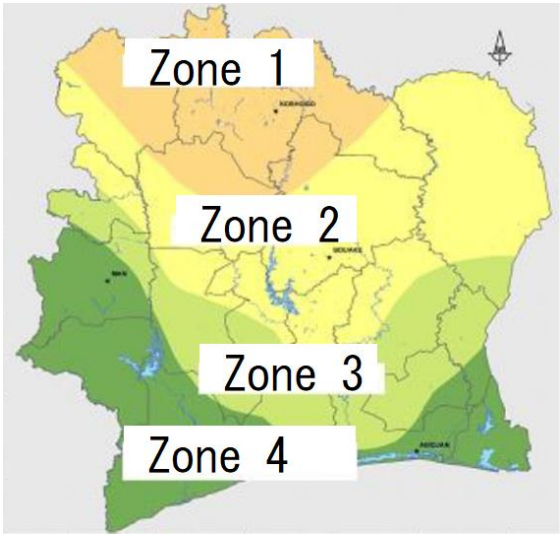


Figure 6-1 Agro-ecological zones in Cote d'Ivoire

Source: Government of Côte d'Ivoire (2014) Agriculture in response to climate change in Côte d'Ivoire (L'agriculture Intelligente face au Climat en Côte d'Ivoir - ezonage agro-climatique)

In 2020, the total value of export from Cote d'Ivoire was USD 11.79 billion (1,295.3 billion yen). The top three export items were cocoa-related products (USD 6.22 billion or 683.3 billion yen; 52.8%); rubber and rubber products (USD 1.36 billion or 149.4 billion yen; 11.5%); and fruits and nuts (USD 1.15 billion or 126.3 billion yen; 9.8%). Overall, the country's export depends on the agricultural sector[196].

As shown in Figure 6-1, Côte d'Ivoire can be divided into four major agro-ecological zones[197]. While zone 1 is characterized by a single rainy season (June to October) and a long dry season, zones 2 to 4 have two rainy seasons and two dry seasons; as such, the rainy seasons are from May to July and October to November in zone 2, from April to July and October to November in zone 3, and from March to June and October to November in zone 4. In addition, the mean annual rainfall is 900–1,400 mm, 1,000–1,500 mm, 1,200–1,600 mm, and more than 1,600 mm in zones 1, 2, 3, and 4, respectively, with more rainfall in the south.

6.1.2. Rice production

Rice is the major cereal crop in Cote d'Ivoire, and as shown in Figure 6-2, production has increased rapidly from 450,000 tons in 2008 to 1.43 million tons in 2015 (in terms of white rice). Within SSA, the country ranks sixth in terms of rice production following Nigeria (8.44 million tons), Madagascar (4.23 million tons), Tanzania (3.47 million tons), Mali (3.2 million tons), and Guinea (2.6 million tons). Rice

[194] World Development Indicator
[195] FAOSTAT
[196] Website of the International Trade Center
[197] Government of Côte d'Ivoire (2014) Agriculture in response to climate change in Côte d'Ivoire (L'agriculture Intelligente face au Climat en Côte d'Ivoir - ezonage agro-climatique).

consumption is also increasing rapidly, and in terms of excess imports (rice imports minus exports), Cote d'Ivoire ranks fifth globally, with the import of 1.32 million tons, following the Philippines (3.03 million tons), Benin (1.53 million tons), Iran (1.42 million tons), and Saudi Arabia (1.39 million tons)[198].

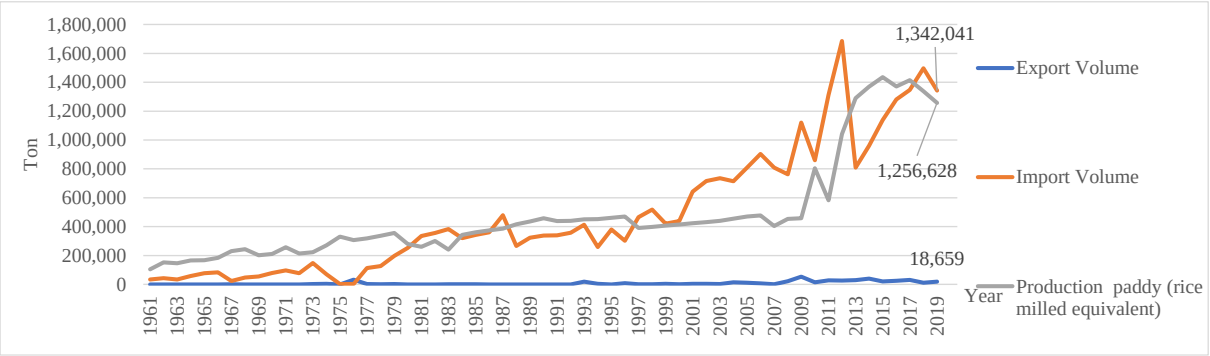


Figure 6-2 Trends of rice production, import, and export in Cote d'Ivoire

Source: FAOSTAT

In 2020, Cote d'Ivoire produced 1,481,181 tons of rice (paddy), with almost all, except 2 out of the country's 104 departments[199], producing rice[200]. Among these, the departments with rice (paddy) production exceeding 10,000 tons are highlighted in Figure 6-3. Korhogo Department produces 230,000 tons of rice, Daloa Department 150,000 tons, Sinfra Department 90,000 tons, Gagnoa Department 80,000 tons, and Vavoua Department more than 70,000 tons.

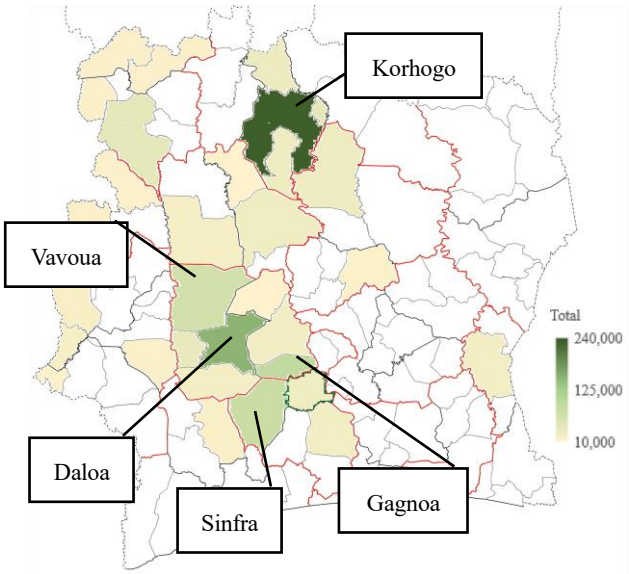


Figure 6-3 Major rice producing area in Cote d'Ivoire (ton) (2020)

Source: Prepared by the survey team based on materials provided by ADERIZ

Rice production areas are broadly classified into three categories; irrigated lands (irrigué), rainfed lowlands (pluvial bas fond et plaine), and rainfed uplands (pluvial plateau). The cultivated area, paddy production, and average yield of each class are summarized in Table 6-1. Rainfed lowlands and uplands account for respectively 47.7% and 48.6% of the total cultivated area. The average yield per hectare is 4.0 tons from irrigated lands, 3.2 tons from rainfed lowlands, and 1.4 tons from rainfed uplands, with 65% of paddy produced in rainfed lowlands.

[198] In terms of excess rice import, many SSA countries rank following Cote d'Ivoire; in terms of rice import, Ghana ranks seventh (1.09 million tons), Mozambique nineth (940,000 tons), Nigeria eleventh (840,000 tons), Cameroon twelfth (830,000 tons), and Senegal thirteenth (760,000 tons) in the world.

[199] Cote d'Ivoire is divided into 14 districts, of which two are cities organized as autonomous districts. The 12 non-autonomous districts are subdivided into 31 regions (second-level). The autonomous districts and regions are divided into departments (third-level).

[200] Materials provided by Agence pour la Developpement de la Filiere Riz en Côte d'Ivoire (ADERIZ)

Table 6-1 Rice production areas in Côte d'Ivoire (2020)

		Irrigated lands	Rainfed lowlands	Rainfed uplands	Total
Cultivation area	ha	23,618	302,877	308,806	635,301
	(%)	3.7	47.7	48.6	100.0
Paddy production	ton	95,485	962,118	423,578	1,481,181
	(%)	6.4	65.0	28.6	100.0
Average yield	ton/ha	4.0	3.2	1.4	2.3

Source: Prepared by the survey team based on materials provided by ADERIZ

6.2. Outline of the major stakeholders

6.2.1. Ministry of Agriculture and Rural Development (Ministère de l'Agriculture et du Développement Rural: MINADER)

MINADER is responsible for the formulation and implementation of agricultural policies. DMEME (the Direction de la. Maîtrise de l'eau dans le domaine agricole et de la. Modernisation des Exploitations) is responsible for agricultural mechanization. DMEME will be the governmental contact point for AFICAT activities, and it is recommended for the AFICAT team[201] to consult on policies and development strategies for agricultural mechanization with DMEME, jointly review and improve AFICAT plans, share information on similar projects to AFICAT, and work with private companies.

The Ministry of Rice Promotion was established as an independent entity from MINADER in September 2019; as of September 2021, however, it was placed under MINADER again, and its future activities were not clear[202].

[201] Since the implementation structure of the AFICAT plan is not clear, the term "AFICAT team" is used for convenience.
[202] Interview with a former technical advisor of the Ministry of Rice Promotion

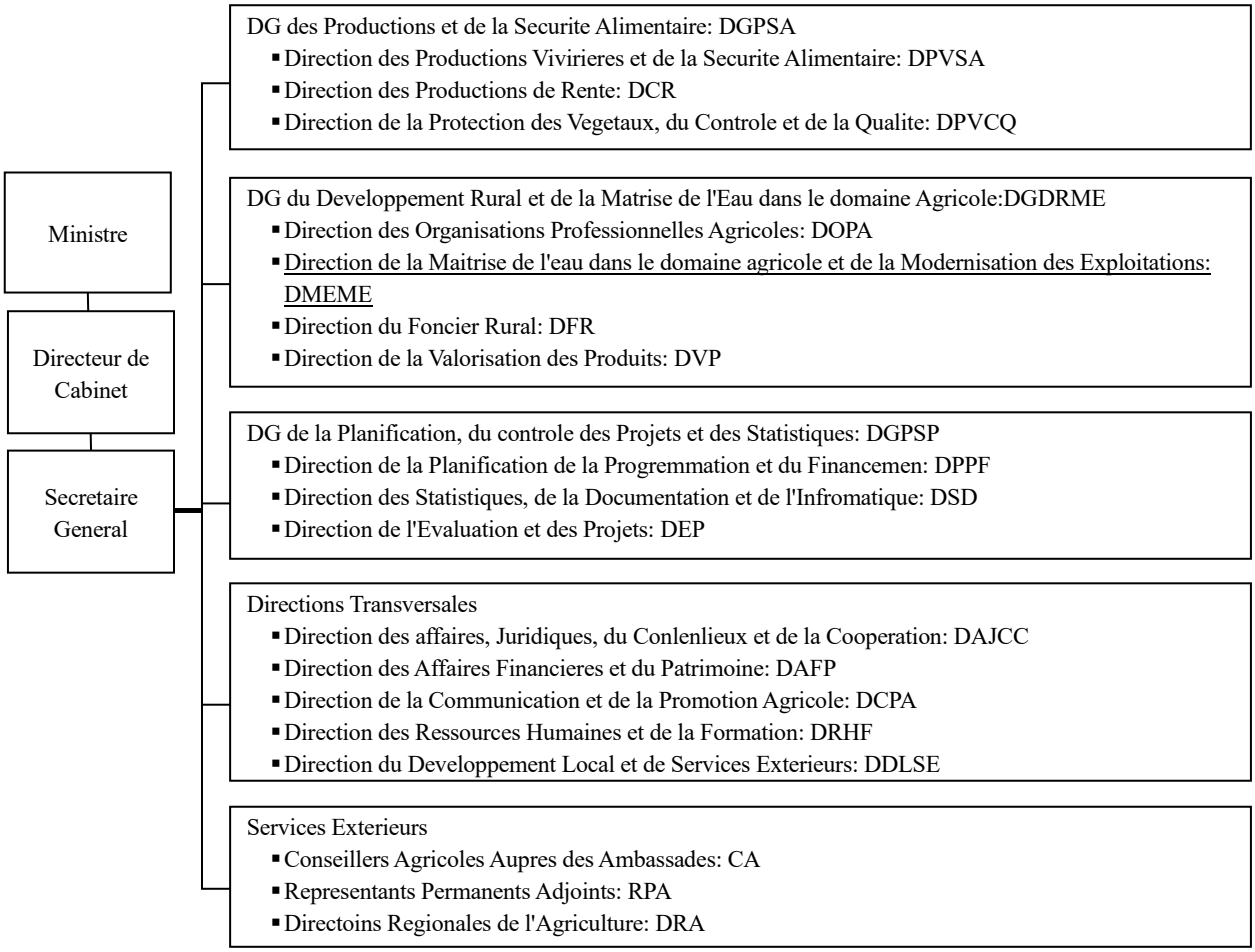


Figure 6-4 Organogram of MINADER

Source: JICA (2019) Report on the Detailed Planning Study for Phase 2 of the Domestic Rice Promotion Project in Cote d'Ivoire

6.2.2. Agency for Rice Development (Agence pour le Développement de la filière RIZ: ADERIZ)

ADERIZ is a public corporation established in 2018 through the transformation of the National Office of Rice Development (Office National de Développement de la Riziculture: ONDR). ADERIZ inherited human resources from its predecessor, ONDR; however, its functioning was made more flexible and independent compared with that of ONDR by creating procedures and budgets similar to those in a private organization. Under the oversight council, it comprises six bureaus headed by the President: the Production Support Bureau, Infrastructure Bureau, Information Systems Bureau, Extension Support Bureau, Statistics and Evaluation Bureau, and Administration and Finance Bureau. Since AFICAT will start with rice-related mechanizations, ADERIZ is expected to be the organization that will effectively collaborate with AFICAT. Specifically, ADERIZ may be involved in the leasing of agricultural machinery, including Japanese agricultural machinery and rice milling equipment. In the implementation of AFICAT, the AFICAT team is expected to exchange views with ADERIZ on the utilization of Japanese agricultural machinery and the dissemination system of agricultural machinery for promoting agricultural mechanization.

6.2.3. National Agent for Rural Development (Agence Nationale d'Appui au Développement Rural: ANADER)

ANADER, a public corporation under MINADER, is in charge of the country's agricultural and rural development. They divide the country into 7 regions and 53 zones, with a total of nearly 2,300 employees working at the headquarters and in other regions. It has four training centers in the country, one of which is the Training Center for Agricultural Mechanization in Grand-Lahou (Le Centre de Formation à la Mécanisation Agricole de Grand-Lahou: CFMAG), as described below. For AFICAT or Japanese companies seeking collaboration with CFMAG, ANADER will be the contact point, including the conclusion of the agreement.

6.2.4. Training Center for Agricultural Mechanization in Grand-Lahou

Established in 1991 with Japanese support, CFMAG, a subsidiary of ANADER, is a training center specializing in agricultural mechanization. It has all the resources for agricultural mechanization training, including office space, plots, instructors (only three), and accommodation facilities. Many Japanese agricultural machineries are also in use there, including Japanese tractors, power tillers, and rice milling equipment[203]. When the survey team visited the center in September 2021, they had to travel for nearly 3 hours to reach due to poor road conditions from Abidjan; however, new road construction has been planned in the near future, which is expected to improve convenience. AFICAT is expected to collaborate with CFMAG for the exhibition, verification, and demonstration of Japanese products and the use of agricultural machinery during training.

Photograph 6-1 Facility and plot of CFMAG

Source: Survey team

6.2.5. AfricaRice

AfricaRice is an international research institute specializing in rice in Africa. It is based in Bouaké, Gbêkê Region (Région de Gbêkê), and has abundant resources, including office space, fields, and researchers. AFICAT is expected to collaborate with AfricaRice for the demonstration, verification, and joint development of Japanese products[204].

[203] Old machines from the 90s, such as the Yanmar rice milling machine and the already discontinued Kubota AR120 rice harvester

[204] For instance, AfricaRice can conduct comparative testing of soil conditioners and activators using equipment and materials available at AfricaRice

Photograph 6-2 AfricaRice

Source: Survey team

6.2.6. Institut National Polytechnique Félix Houphouët-Boigny (INPHB)

The Félix Houphouët-Boigny National Polytechnic Institute (INPHB) is an educational institution that offers degrees, masters, and doctorates in agricultural machinery. Located in the capital city of Yamoussoukro, INPHB is placed at a convenient location and has well-maintained machine tools. AFICAT is therefore expected to collaborate with INPHB for the demonstration and verification of Japanese products as well as for machining necessary for the production and improvement of simple parts.

Photograph 6-3 Facility of INPHB

Source: Survey team

6.3. Related policies, strategies, and development plans

MINADER is in charge of the agricultural sector, and although the Ministry of Rice Promotion was established in September 2019, it had already been absorbed by MINADER by the time of the field survey in September 2021. Operations related to rice promotion are handled by ADERIZ, a public corporation organized in 2018 through the modification of ONDR. The main plans, programs, and strategies of the Government of Côte d'Ivoire for agriculture and rice development are summarized below.

6.3.1. National Development Plan (le Plan National de Développement)

When President Alassane Ouattara assumed office in May 2011 and a new government was formed, a new economic strategy was launched to reduce the poverty rate by over 50% by 2020 and make Cote d'Ivoire an emerging country. The strategy was formulated in two phases: the First National Development Plan (le Plan National de Développement), which laid the groundwork for achieving the goals between 2012 and 2015, and the Second National Development Plan (2016-2020), which was formulated based on the lessons of the First National Development Plan in achieving the goals. The goals were to i) create jobs and achieve growth considering gender equality and environmental sustainability; ii) increase value addition in the processing of primary commodities (cocoa, coffee, cashew nuts, and cotton, among others); iii) create the best business environment in Africa and the world in terms of human development indicators; iv) become an advanced country in terms of human resource development indicators, v) be among the best countries in Africa in terms of good governance and fighting corruption; and (vi) play a leading role in sub-regional and African integration.

6.3.2. National Agricultural Investment Program (Programme National d'Investissement Agricole)

In line with the above-mentioned National Development Plans and other frameworks[205], the National Agricultural Investment Program Phase 2 (Programme National d'Investissement Agricole 2018-2025, édition 2018: PNIA2) has been developed, which provides an investment plan for the agricultural sector for the period 2018–2025. PNIA2 aims to halve poverty and reduce hunger to zero by 2025, and in 8 years, the plan is expected to invest XOF 4,325.4 billion (854.8 billion yen) in the public sector to stimulate growth in the agriculture, livestock, fisheries, aquaculture, and environmental management sectors.

Specifically, rice, maize, coffee, cooking banana, poultry, fish, cotton, palm oil, beef, cocoa, cassava, cashew nuts, and rubber have been identified as priority crops in terms of i) improving smallholder incomes, ii) contributing to employment, and iii) contributing to food security and household food expenditures. From the agro-ecological, administrative, and socio-economic perspectives, the country is divided into nine zones, and comprehensive agricultural development is planned in each zone. In seven of these nine zones, rice is designated as a priority food crop. Table 6-2 summarizes the necessary actions and methods to promote agricultural mechanization.

[205] In addition to the National Development Plan, PNIA2 was developed in line with the framework set out in i) the Comprehensive Africa Agriculture Development Program (CAADP) adopted in Maputo, Mozambique in 2003; ii) its implementation at the ECOWAS level through the Economic Community of West Africa Agricultural Policy (ECOWAP); iii) the 2014 Malabo Declaration on Agricultural Transformation; iv) SDGs; and v) the framework set out in ECOWAP+10, which introduced strategic measures to accelerate progress in West Africa.

Table 6-2 Actions to promote agricultural mechanization and required steps under PNIA2

	Action	Steps
1	Determining measures for agricultural mechanization	▪ Review of the failures of past mechanization programs and policies and incorporating the lessons learned into new policies ▪ Improvement of tax exemption for agricultural machinery ▪ Simplification of import procedures for agricultural machinery and equipment
2	Promoting the development of new technologies and equipment that meet the demands of stakeholders	▪ Development of incubators dedicated to research on the mechanization of agriculture, forestry, and fisheries
3	Providing agricultural materials and equipment taking the needs of each region into account	▪ Introduction of agricultural machinery for shared use at the regional council level and its lending to producers ▪ Establishment of mechanization centers in each region and strengthening of the capacity of existing centers ▪ Establishment of companies for manufacturing, sales, and rental in production centers

6.3.3. Agricultural Mechanization Strategy

The draft version of the Agricultural Mechanization Strategy (Ministre de l'Agriculture Strategie Nationale du Developpement de la Mechanisation Agricole) was already in place as of 2015. When the preceding survey team visited DMEME in March 2019, they intended to obtain approval by the end of 2019; however, as of September 2021, the strategy had not yet been approved.

6.3.4. National Rice Development Strategy

Similar to many SSA countries, Côte d'Ivoire relies on imports for much of its rice consumption. The National Rice Development Strategy (La Stratégie Nationale de Développement de la filière Riz: SNDR) was developed in 2008 and was revised in 2012 to strengthen activities for achieving the set goal. The revised SNDR set the goal of achieving rice self-sufficiency by increasing rice production from 604,000 tons in 2008 (929,600 tons on a paddy basis) to 2.11 million tons by 2018 (3.25 million tons on a paddy basis). However, rice production in 2018 was only 1.34 million tons (2.01 million tons on a paddy basis). As shown in Figure 6-5, the area under rice cultivation in rainfed areas is decreasing rather than increasing, although the cultivation area and yield in irrigated areas and floodplains have achieved the target.

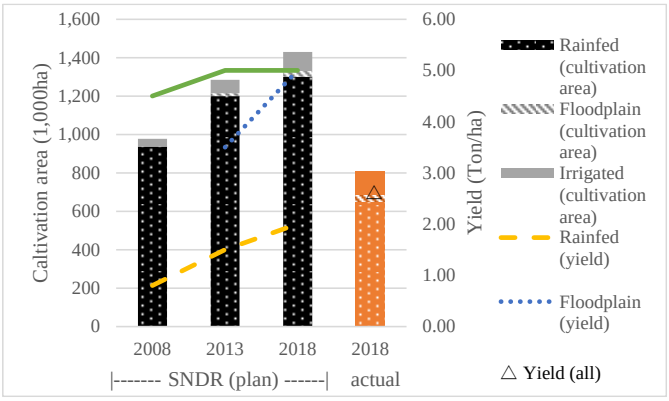


Figure 6-5 Planned and actual paddy cultivation are of SNDR (2012)

Note: The left axis shows cultivation area, and the right axis shows yield. The three bars on the left show planned values, and those on the far right show actual values.
Source: SNDR (2012), SNDR (2020)

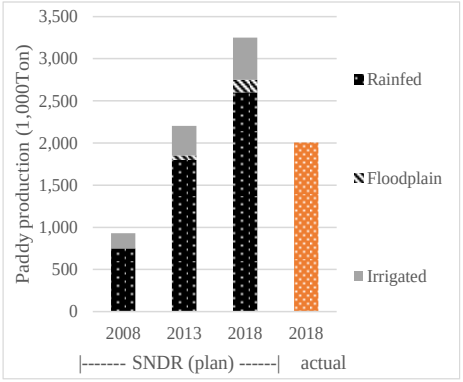


Figure 6-6 Planned and actual paddy production of SNDR (2012)

Note: The three bars on the left show planned values, and those on the far right show actual values.
Source: (Same as the left)

In 2020, SNDR Phase 2 (SNDR2) was formulated, which outlines a strategy for the period up to 2030. Here, the goals are to achieve self-sufficiency in rice by 2025 and to make Cote d'Ivoire the largest rice exporter in Africa by 2030. The strategy indicates the country's intention to secure rice production by shifting from rice cultivation on floodplains and rainfed areas to drip irrigation.

Table 6-3 Plan of rice production in Cote d'Ivoire

	unit	2020	2021	2022	2023	2024	2025	2030
Flood plains	(ha)	30,000	30,000	30,000	30,000	20,000	20,000	0
	(ton)	90,000	90,000	90,000	90,000	60,000	60,000	0
Rainfed lowlands	(ha)	425,000	400,000	350,000	300,000	250,000	100,000	0
	(ton)	850,000	800,000	700,000	600,000	500,000	200,000	0
Rainfed upland	(ha)	425,000	425,000	425,000	400,000	350,000	100,000	0
	(ton)	425,000	425,000	425,000	400,000	350,000	100,000	0
Irrigated land	(ha)	35,000	51,463	51,463	51,463	51,463	51,463	51,463
	(ton)	350,000	514,630	514,630	514,630	514,630	514,630	514,630
Drip irrigation	(ha)	0	50,000	100,000	150,000	200,000	250,000	500,000
	(ton)	0	700,000	1,400,000	2,100,000	2,800,000	3,500,000	7,000,000
Total	(ha)	915,000	956,463	956,463	931,463	871,463	521,463	551,463
	(ton)	1,715,000	1,829,630	3,129,630	3,704,630	4,224,630	4,374,630	7,514,630

Note: Two crops per year in irrigated land as well as drip irrigation areas are assumed. Average yield is assumed to be 3 ton/ha in floodplains, 2 ton/ha in rainfed lowlands, 1 ton/ha in rainfed uplands, 5 ton/ha in irrigated lands, and 7 ton/ha under drip irrigation.
Source: SNDR2

6.3.5. Other measures related to rice

(1) Agricultural machinery leasing businesses[206]

As an emergency support measure for COVID-19, ADERIZ received a special budget of XOF 2.3 billion (454.53 million yen) in 2020 and XOF 1.6 billion (316.19 million yen) in 2021 to promote the purchase of agricultural machinery. Using these funds, agricultural machinery shown in Table 6-4 was purchased from the budget of 2020. The type of agricultural machinery was selected by ADERIZ. According to ADERIZ, the reason Japanese companies' products, such as power tillers and combine harvesters, were selected was that "although Japanese products are more expensive than Chinese products, their durability and performance are superior." The purchased machines will be leased to agricultural machinery service providers[207].

Table 6-4 Type and number of agricultural machinery purchased by ADERIZ (2020)

Agricultural machinery	Brand	Units
Power tiller	Japanese brand (Kubota)	60
Combine harvester	Japanese brand (Kubota)	10
Small power tiller	Chinese brand	61
Tractor (39 to 70 hp)	John Deere and New Holland	25
Reaper	Chinese brand	64
Thresher	Chinese brand	63

Source: Prepared by the survey team based on interview with ADERIZ

(2) Introduction of rice milling equipment[208]

With the help of a loan from India's EXIM Bank, there are plans to introduce 30 rice mills with a processing capacity of 5 tons per hour in the country. The government will provide the land and buildings to

[206] Interview with ADERIZ
[207] After leasing, it will be purchased
[208] Interview with ADERIZ

the rice millers under a 35-year contract, and the millers will pay rent and repay the cost of the rice milling equipment (XOF 300 million or 5.9 million yen) over 10 years. As of September 2021, 20 of the 30 facilities were installed.

6.4. Donor support

6.4.1. Supports from the Japanese Government including JICA

(1) Recent JICA projects implemented

JICA has been implementing the technical cooperation project called the "Project for Domestic Rice Promotion in Cote d'Ivoire" (Projet de Promotion du Riz Local en République de Côte d'Ivoire: PRORIL) since 2014. As a result, the production and sales volume of the target farmers has increased by 50% compared to the pre-project level; financial institutions have entered the rice sector; and the cooperation among value chain stakeholders has been successful. To further promote locally produced rice, financial services must be expanded for rice millers and dealers who are highly motivated to sell locally produced rice in the rice value chain, seed production and post-harvest processing must be improved to enhance the quality of locally produced rice; appropriate agricultural machinery should be introduced and maintenance techniques improved; and agricultural machinery services should be enhanced[209]. For the purpose, the phase 2 of PRORIL (PRORIL2) was launched in February 2021.

In the 1980s and 1990s, JICA supported the construction of CFMAG through a grant aid and implemented a technical cooperation project on agricultural mechanization to promote agricultural mechanization in Cote d'Ivoire.

Table 6-5 Recent JICA projects related to agriculture implemented in Cote d'Ivoire

Project name	Period	Implementing organization	Outline
PRORIL	February 2014 to March 2020	Responsible organization: MINADER* Implementing organization: ADERIZ**	The project aimed to increase the volume of rice sales by the target producers based on the following four outcomes: promotion of stakeholder dialogue, utilization of knowledge and skills gained from training by the target group, supply of necessary elements to producers/millers/distributors for demonstrating the results of training, and acceleration of stakeholder efforts to promote locally produced rice.
PRORIL2	February 2021 to February 2026	Responsible organization: MINADER Implementing organization: ADERIZ	The project aims to increase the quantity and quality of rice sold through the establishment of a bankable domestic rice supply chain. The project supports farmers, millers, and distributors to improve agricultural financial services, agricultural machinery services, capacity to produce and use quality seeds, and strengthen post-harvest processing and quality control technologies.
Training Plan for Irrigated Rice Cultivation Mechanization	August 1992 to July 1997	Ministry of Agriculture and Animal Resources (at the time), Food Development Corporation (now	The purpose of this project was to promote mechanized irrigated rice cultivation and thereby increase rice production by providing CPs with technology for the operation and maintenance of agricultural machinery and irrigated rice cultivation at CFMAG constructed with grant assistance.

[209] PRORIL2, the report on the detailed planning survey

Project name	Period	Implementing organization	Outline
		ANADER)	
Construction Plan for Training Center on Agricultural Mechanization (CFMAG)	1988 to 1989	(Same as above)	Construction of field and training facilities for the purpose of education and training of mechanization and irrigated rice cultivation and procurement of training equipment. The total amount of cooperation was 954 million yen.

Note: *Ministry of Agriculture (Ministère de l'Agriculture: MINAGRI) was reconstructed to MINADER in January 2016.
**ONDR was reconstructed to ADERIZ in January 2018.
Source: JICA (2020) Project completion report of PRORIL
JICA (2019) Report on the detail design study for PRORIL2
JICA (1992) Report on the Consultative Mission to Cote d'Ivoire on the Implementation of the Training Plan for Irrigated Rice Cultivation Mechanization
Website of the Ministry of Foreign Affair[210]

(2) Grant Aid for the Increase of Food Production/Grant Assistance for Underprivileged Farmers (2KR)

Table 6-6 shows the number of agricultural machines introduced through 2KR in the past. As over 20 years have passed since the 2KR support ended, the number of agricultural machines in operation could not be confirmed in the preceding or this survey. The performance of the Japanese agricultural machinery introduced at that time was highly regarded by the government officials interviewed in this survey. Nonetheless, Japanese agricultural machinery did not take root in the 2KR because of insufficient after-sales service and part supply after provision. Furthermore, due to the civil strife in Cote d'Ivoire, Japanese companies were forced to withdraw from the country or were reluctant to enter the market. In the future, local dealers/agents must be established and after-sales service structure must be strengthened in cooperation with local dealers/agents. In this survey, it was confirmed that some Japanese agricultural machinery manufacturers are already considering entering the market.

Table 6-6 Machinery introduced through 2KR in Cote d'Ivoire (unit)

Machinery	FY													Total
	86	88	89	90	91	92	93	94	95	96	97	98	99	
Tractor	21	10	0	0	0	0	0	10	0	10	10	10	0	71
Power tiller	85	100	0	0	157	64	247	100	52	0	83	90	70	1,048
Reaper	35	50	120	50	150	0	0	0	0	0	0	0	0	405
Thresher	35	65	75	40	140	40	0	0	0	35	0	0	0	430
Rice mill	0	0	20	20	20	0	45	30	0	26	0	0	0	161
Water pump	0	0	0	0	0	0	0	10	10	0	0	10	10	40
Paddy dryer	0	0	0	0	0	0	0	0	0	4	0	0	0	4
Other thresher	0	0	0	0	0	0	0	0	0	0	5	0	0	5
Seed selector	0	0	0	0	0	2	0	0	0	0	0	0	0	2
Leveler	1	0	0	0	0	0	0	0	0	0	0	0	0	1

Source: Preceding survey report

6.4.2. Supports from other donors

Donor projects related to rice and agricultural machinery are summarized in Table 6-7.

[210] https://www.mofa.go.jp/mofaj/gaiko/oda/shiryo/hyouka/kunibetu/gai/h10gai/h10gai62.html

Table 6-7 Other donors' project in Cote d'Ivoire

Donor (project name)	Period	Outline
IFAD (Projet d'Appui au Développement des filières Agricoles : PADFA)[211]	2017 to 2025	The Agricultural Value Chain Development Support Program targets Savanes and Vallee du Bandama districts in northern and central Cote d'Ivoire. The goal of the program is to increase food security and farmers' income through the development of agricultural value chains. The project targets rice, horticultural crops, and mangoes and provides matching grants of 40–60% for the required processing machinery. The project budget is USD 72.51 million (8 billion yen).
Government of India/EXIM Bank (Rice Project)[212]	Ongoing	The project will install 30 rice milling facilities with a capacity of 5 tons per hour. The budget is USD 30 million (3.3 billion yen) as loan.
African Development Bank (AfDB) (Le Projet de Pôle Agro-Industriel dans la région du Bélier: 2PAI-Bélier)[213]	2017 to 2022	The project aims at comprehensive transformation of the agricultural sector in the Berrié Region and Yamoussoukro Autonomous district. It involves the rehabilitation of three dams, development of 1,835 ha of irrigated land, and establishment of a training center for agriculture and animal husbandry. The total project cost is EUR 123.47 million (16 billion yen), of which EUR 64.36 million (8.3 billion yen) is an AfDB loan, EUR 33.15 million (4.3 billion yen) is an Le Fonds Africain de Développement (FAD) loan, and EUR 4.33 million (560 million yen) is an FAD grant, and EUR 21.65 million (2.8 billion yen) is from the government and beneficiaries.

6.5. Overview of agricultural mechanization

In Cote d'Ivoire, agricultural machinery is mostly used in large estates or plantations that produce commodity crops, such as sugarcane and oil palm. The machinery is mainly used for transporting harvested oil palm bunches in large plantations by towing trailers on tractors. In this case, the workload is less than that in land preparation, but the service life and operating hours are longer. This is one of the important criteria for the selection and evaluation[214] of agricultural machinery. The current status of the use of agricultural machinery in rice-growing areas observed in this survey is described below.

Photograph 6-4 A large oil palm plantation located between Gran Laud and Abidjan

Source: Survey team

6.5.1. Current status of mechanization in rice-growing areas

Prior to the field survey, the team conducted interviews with MINADER, ANADER, and ADERIZ in Abidjan. The following are some of the issues emphasized by the above-mentioned government agencies to improve rice productivity and promote mechanization:

[211] Interview with IFAD and website of IFAD (https://www.ifad.org/en/web/operations/w/country/c%C3%B4te-d-ivoire)
[212] Interview with ADERIZ
[213] Interview with government officials of Bélier Region and website of AfDB and 2PAI - Bélier (https://2pai-belier.ci/presentation-du-projet/; https://www.afdb.org/fr/documents/document/cote-divoire-belier-region-agro-industrial-pole-project-appraisal-report-93957)
[214] The performance of agricultural machinery is greatly influenced by the capability of the machine as well as the operator's skill, soil and crops conditions, and work plot size. These conditions must be considered when evaluating machinery.

1) Productivity is low because very few machines are available, which delays the work, resulting in losses during harvest.
2) The plots are rather small for the introduction of machines, making efficient work difficult.
3) Some small plots still have stumps that were cut down during land preparation, making it impossible to introduce machinery.
4) Prices of agricultural machinery are high, while after-sales services from dealers are almost non-existent, and consumable parts may not be readily available.
5) There is lack of skills and experience among operators, leading to improper operation and irregular maintenance of the machines, which often results in premature breakdown.

Photograph 6-5 shows rice growing areas on the way from Yamoussoukro to AfricaRice near Bouake. A power tiller was used, but since the plots were small, the machine had to be turned frequently within the plot. This leads to heavy wear of jaw clutches (engaging clutches). Similar to the practice in other countries, small plots are created to facilitate manual leveling of the field surface after puddling.

Direct puddling is often performed twice. Fuel costs are charged separately.

Power tiller (China-made) being refueled; a hopper-type water-cooled engine is used.

Photograph 6-5 Direct puddling work in rainfed lowland areas

Source: Survey team

The tiller wheel (puddling wheel) in Photograph 6-5 is rare in other countries. Wheels used in muddy irrigated field can reduce subsidence and increase traction force without destroying the hardpan. Photograph 6-6 shows wheels for paddy fields that were observed during the survey. Since the performance of wheels varies depending on soil conditions, appropriate wheels must be investigated and verified as one of the AFICAT activities. Based on the results, wheels can be improved or fabricated after testing in the field.

Power tiller and paddy wheel at a rice mill in Yamoussoukro.

A cage wheel placed in a paddy warehouse in Yamoussoukro.

Paddy wheels placed in the CFMAG machinery shed.

Photograph 6-6 Wheels for paddy field

Source: Survey team

Photograph 6-7 shows an upland field on slightly higher ground than the rice field in Photograph 6-5. No plowing is performed with a disc plow, and soil is simply crushed with a disc harrow. The tilling depth of the disk is around 10–15 cm, and the soil has adequate moisture for pulverization.

Tomatoes and other horticultural crops were planted in the neighborhood, and the rows between the tomato fields were neatly weeded. High ridges with a gentle slope are created between the rows to promote drainage during rainfall. Whether ridging after harrowing is completed with a machine or manually could not be confirmed.

Service charge is XOF 60,000 (11,860 yen)/ha (including fuel). John Deere 5075E (75 hp)

Tomato field. The rows are gently sloping, and the front is lower.

Photograph 6-7 Upland field

Source: Survey team

There are two types of service providers: services provided by wealthy farmers using their own machines and by PMEAs[215] ("small and medium agricultural enterprises," referred to as "service providers" in this report, as in other countries). PMEAs include companies that provide only agricultural machinery services as well as those that are primarily engaged in agricultural management and have a legal body.

In this survey, two service providers were visited. The summary is as follows:

The first service provider is located in Yamoussoukro and is a subsidiary of a company that is mainly in the road and building construction business. The company has 150 ha of irrigated land and produces and sells rice. After harvesting, they outsource for milling crop to a rice mill with a milling capacity of 2 ton/h. The milling charge is XOF 62 (12 yen)/kg of paddy grains. The company owns three tractors (two 80 hp CASE and one 70 hp John Deere), three units of rotary, two disc plows, one tractor-mounted sprayer, two power tillers and two reapers (both made in

Photograph 6-8 Rotary mounted on a CASE tractor

Source: Photographed and provided by G. Co.

It can be seen that the machine is turning without raising the rotary.

Photograph 6-9 Direct puddling work

Source: Photographed and provided by G. Co.

[215] PMEA is an abbreviation of Petites et Moyennes Entreprises Agricoles. Translated as small and medium enterprises in English.

China), four throw-in type threshers[216] (hereafter referred to as "threshers"), and two combine harvesters (Kubota DC70, grain-tank type). All machines were purchased within 6 months before the interview in September 2022. However, reapers are rarely used due to muddy field conditions and poor reaping performance. Even when providing machinery services, priority is given to work on 150 ha of fields owned by the company. In other words, service provision is not their main business. Provision of agricultural machinery services, service charge, work efficiency, and work methods obtained from the interviews are summarized below. For direct puddling work, the service charge is XOF 90,000 (17,790 yen)/ha for two operations using a tractor with a rotary, but the fee may be higher if the field plot is smaller. In some cases, temporary bunds may be broken to increase work capacity. The broken temporary bunds are re-built after puddling by the farmer who commissions the work. The tractor's capacity for direct puddling varies depending on the field conditions, but on average, the first puddling requires nearly an hour per hectare and the second nearly 20 to 30 minutes, totaling around 1.5 hour/ha. If the hardpan is soft enough for the tractor to sink, they refuse to work on it or use a power tiller. The power tiller service has the same working methods and charges as the tractor service. However, nearly 3 days of work per hectare is required to improve the puddling conditions. The service charge for direct puddling work using tractors and power tillers is XOF 85,000 (16,800 yen)/ha with a discount[217] if the field condition is good (properly irrigated before work), access to the field is easy, and the plot is large enough to allow work. The company does not provide rice transplanting services. However, for rice transplanting in their own fields, they hire laborers and pays XOF 65,000 (12,850 yen)/ha. To complete transplanting in a hectare in a day, 10 to 30 workers are required, depending on the experience of the workers in manual planting. Rice transplanting is performed using the straight line planting method.

Although the photograph is blurry, planting string and pegs can be seen.

Photograph 6-10 Rice transplanting work

Source: Photographed and provided by G. Co.

Photograph 6-11 Bagging work from a combine harvester

Source: Photographed and provided by G. Co.

As mentioned above, there is no service provides of reapers during harvest. Thresher services charge XOF 65,000 (12,850 yen)/ha for manual reaping and collection by farmers but do not offer bagging service. A combine harvester is used only in one cropping season. The service charge is XOF 120,000 (23,710 yen) /ha. The combine harvester is grain-tank type, and paddy grains discharged from the unloader are placed in rice bags prepared in advance by farmers. As shown in Photograph 6-11, the paddy field is not facing to the farm road. Farmers do not bother to bag rice in the field if the field faces the farm road (it is more efficient to

[216] In countries and regions where rice varieties with easy threshability are grown, a head-feeding type thresher, similar to the one used in Japan, cannot be used.

[217] Such discounting is to secure customers and is common in other countries as well. As an increasing number of service providers have started offering machinery services, the prices are reducing and service quality is improving to secure customers.

bag rice on the farm road because the bagged rice needs to be transported to the next drying site). In such cases, farmland consolidation is necessary. While service providers are not affected by the efficiency of combine harvesters in discharging grains on farm roads or in the field, they tend to be more careful for securing customers if the number of competitors increases. The service providers handle the daily inspection of their own machinery, however they ask machinery dealers to handle repairs, complex part replacement, and maintenance. The company aims to establish their own rice mill by the end of 2021 and expand their current 150 ha of field to 500 ha. The team was not able to confirm any equipment related to rice milling.

Photograph 6-12 Seeder with fertilizer applicator
Source: Photographed and provided by F. Co.

The office of the other company the team visited is also located in Yamoussoukro, where they rent 150 ha of farmland but do not produce rice. The company started in 2016 and has 14 employees, including machine operators. They mainly grow cassava, yams, and maize. With production of around 30 ton/ha, cassava is the most profitable crops. Not all of the 150 ha of farmland is used for field crop production due to fallowing, crop rotation, and crop shifting as well as management constraints. The company owns three tractors (one 90 hp CASE and two 75 hp Turkish McCormick), two 4-disc plows (Turkish), one disc harrow (32 discs), one rotary (2-m width, Turkish), one 7-ton trailer, one 2-disc type ridger for yam, one 4-disc type ridger, one 16 m width boom sprayer (600 L tank), and one 4-row Turkish seeder with a fertilizer applicator. The seeder was purchased from ATC COMAFRIQUE (distributor).

Photograph 6-13 Rotary, mainly used in paddy field
Source: Photographed and provided by F. Co.

The machinery service charge is XOF 50,000 (9,880 yen) /ha for plowing with a disk plow and XOF 40,000 (7,900 yen)/ha for one-time work with a disk harrow. Cassava, yams, and maize require harrowing work after plowing, and it may be required more than once depending on the pulverizing conditions of the soil.

The company offers direct puddling services for paddy fields. For the CASE tractor with rotary, the charges are XOF 50,000 (9,880 yen)/ha for one operation and XOF 90,000 (17,790 yen)/ha for two operations. Two operations of direct puddling require around 1.5 hours/ha depending upon the field conditions. During direct puddling work in wetlands, including irrigated areas, the tractor may sink; thus, field conditions must be carefully assessed.

The company provides services in Sacasso, which is the north of Bwake. In remote areas, they charge a machine transportation fee in addition to the service fee. They do not charge a transportation fee within 15 km of the head office where the machinery is located; the charges are XOF 1,000 (200 yen)/km for longer distances.

To expand their business, the company plans to lease three threshers from ADERIZ at a price of

XOF 3 million (590,000 yen) per unit with engine, with 5% down payment and the rest in 5 years[218].

6.5.2. Current status of post-harvest (threshing) work

The harvested paddy grains are dried on water-resistant canvas sheets, blue sheets (made of polyethylene), or concrete pavement as a drying yard. The drying yards are located in the space of rice mills, while the sheets are shared by farmers' organizations. In all cases, improper drying after threshing is a problem[219] due to unpredicted rainfall during sun drying or cracking of grains from moisture loss because of rapid drying under direct sunlight.

Rice mill in Yamoussoukro

Warehouse owned by the farmers' union in Yamoussoukro

Photograph 6-14 Rice mill and warehouse in Yamoussoukro

Source: Survey team

When rice farmers are unable to purchase the seeds, fertilizers, and pesticides for their crops or to pay the machinery service charges, they often acquire loans or in-kind donations from rice mills or brokers. The debt is deducted from the paddy harvested by the farmers[220]. At the time, the unit price of paddy grains is determined based on grain conditions; however, it is difficult to properly evaluate the quality of paddy grains. If the grain quality is obviously poor, that is, if the grains are contaminated, dirty, or empty[221], the paddy may not be accepted[222] for service. The purchase price (farmgate price) of paddy grains varies widely from XOF 200–300 (40–60 yen)/kg[223]. The only rice mill surveyed there was the one in Yamoussoukro[224], which is operated by the ADERIZ staff. The rice mill was established in 2019 and works as a custom miller. They have installed a compact rice milling plant made in China. The machine includes a bucket elevator that lifts grains from the receiving hopper, a horizontal shaft rotary-type pre-cleaner (scalper), a destoner, a 5-inch rubber roll, a paddy separator, and a one-pass of abrasion whitener.

[218] Agricultural machinery introduced using the COVID-19 budget described above.
[219] According to the staff of ADERIZ in charge of postharvest process, PRORIL2 staff (former JICA trainees)
[220] Explained by rice millers visited during this survey, Tree consulting staff, and CFMAG staff (former JICA trainees)
[221] Even if the harvested grains are well-winnowed and free of impurities, if there are cracked grains due to the hasty drying process, the rice will be broken.
[222] Staff of Tree consulting Co.
[223] Purchase price of paddy grain was confirmed in various places.
[224] The team intended to visit a rice mill with a milling capacity of 5 tons per hour, which was established with a loan from the EXIM Bank of India, but was unable to enter due to a sudden event on the day.


Photograph 6-15 Compact milling plant

Source: Survey team

The milling charge is XOF 30 (6 yen)/ kg of white rice after milling. The bran is the share of the rice mill, which is sold at XOF 50 (10 yen)/kg. Rice husk is sold at XOF 200 (40 yen) per 100 kg. Both bran and rice husks are mainly sold to poultry farmers, and rice husk is used for mulching in poultry houses[225].

Photograph 6-16 shows white rice of the WITA9 variety after milling. There are many different varieties, colored grains, and chalky grains. Since the machine is equipped with a one-pass abrasion-type whitener, bran powder and bran layer remain. Furthermore, compared with the friction-type whitener, the abrasion-type whitener operates at a lower pressure but produces more broken rice. This may be because of rapid drying under direct sunlight, which has already cracked grains.

White rice right after milling process

At a supermarket in Abidjan, white rice from Thailand was sold at XOF 715 (140 yen) per kg.

Photograph 6-16 White rice

Source: Survey team

According to the PRORIL2 survey, the retail price of white rice is XOF 350–450 (70–90 yen)/ kg for locally produced rice mixed with different varieties and XOF 600–700 (120–140 yen) /kg for imported rice sold in supermarkets.

[225] Rice husks are generally treated as a nuisance by rice mills because they are not easy to dispose. However, rice husks from rice mills in Asia, Africa, and Central and South America are used as mulch in pig and poultry farms or banana and other orchards or as fuel for baking bricks; however, they are most likely provided free of charge.

6.6. Agriculture inputs (seeds, fertilizers, and agrochemicals)

6.6.1. Seeds

According to ADERIZ, only 30% rice farmers in irrigated areas and less than 5% farmers in rainfed areas use CS guaranteed by the government[226]. Most rice farmers use their own seeds, as they sell seeds to one another at lower prices than the market price of CS and as access to CS is limited[227].

Seeds in Cote d'Ivoire are classified as original seeds (G0), pre-basic seeds (G1, G2, and G3), basic seeds (G4), and commercial seeds (R1 and R2)[228]. The Centre National de Recherche Agronomique (CNRA) and AfricaRice produce G0 to G3. G3 is provided to ADERIZ and private seed production companies. ADERIZ and private seed production companies produce G4, R1, and R2. CS used by farmers for rice production corresponds to R1 and R2 (Figure 6-7). ADERIZ outsources the production of G4, R1, and R2 to agricultural cooperatives and private seed production companies and then sells the purchased R1 and R2 to farmers[229]. According to the agricultural cooperative contracted by ADERIZ to produce G4 and R1 in 2020, ADERIZ provided seeds, fertilizers, and herbicides and sold the produced G4 and R1 for XOF 250–275 (49-54 yen)/kg.

According to BILOHF, a private seed production company, the demand for CS (rice) has increased. The company produced 220 tons of CS (rice) in 2019, 280 tons in 2020, and plans to produce 650 tons in 2021 by building irrigation facilities[230]. As of September 2021, no subsidy program for farmers to purchase CS was confirmed.

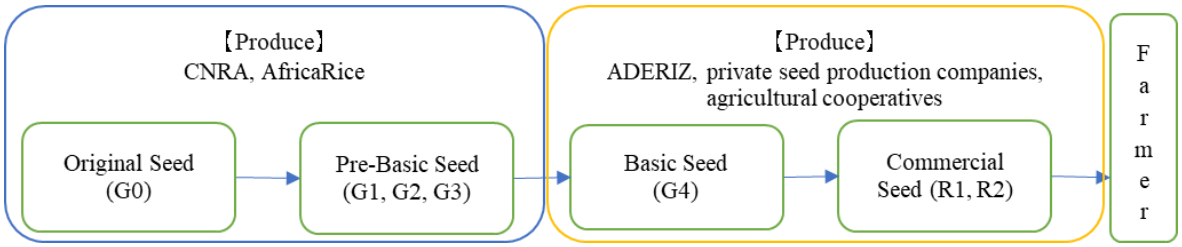


Figure 6-7 Seed production flow

Source: Processing certified seed (draft) (English translation), local public institutions, private companies

Hybrid rice seeds are also available in Cote d'Ivoire. CALLIVOIRE, a subsidiary of UPL, India's leading agriculture material company, has started selling ARIZE 6444 GOLD (XOF 15,000/3 kg) in 2019, which is native to India. According to the explanatory document provided by the company, ARIZE 6444 GOLD is a variety for cultivation in irrigated areas (fragrant rice) and has a yield of 6 to 10 tons/ha.

Photograph 6-10 Hybrid rice seed

Source: Photographed by the survey team

[226] According to SNDR, only 5.7% (353 tons) of the demand in the irrigated rice cultivation areas and 0.9% (243 tons) of the demand in the rainfed rice cultivation areas were distributed with CS (2018).
[227] According to the Association des Semenciers de Côte d'Ivoire (ANASEMCI), the price of direct sales among farmers is around XOF 300–600/kg, which is lower than the price of ADERIZ's CS sale (XOF 600/kg). According to ADERIZ, it is difficult for rice farmers in other regions to purchase CS because of the travel distance, since ADERIZ sells CS in Yamoussoukro.
[228] MINADER et al. (NA) Processing certified seed (draft) (English translation) (Expert of PRORIL2).
[229] G4 is sold at XOF 1,000/kg and R1/R2 at XOF 600/kg; farmers who buy G4 produce R1 and R2 and sell them to other farmers.
[230] As of September 2021, the company was already producing 150 tons of rice CS.

6.6.2. Chemical fertilizers

The average use of chemical fertilizer in Cote d'Ivoire is 35 kg/ha, which is very low compared with the world average of 140 kg/ha[231]. Of the total consumption of chemical fertilizers, 40% is used for cotton cultivation and less than 5% for irrigated rice cultivation[232].

CNRA recommends using 50–200 kg/ha of NPK12-24-18 as base fertilizer and 25–100 kg/ha of urea as additional fertilizer for rice cultivation[233].

Photograph 6-11 NPK sold by D.M.G
Source: Photographed by the survey team

Fertilizers for rice cultivation are sold in Abidjan and Yamoussoukro. For instance, D.M.G. (Abidjan) sells NPK12-22-22 +2SO3+1MgO+5Ca (XOF 20,000/50 kg) and urea (46%) (XOF 23,000 /50 kg) and CALLIVOIRE (Abidjan, Yamoussoukro) sells NPK15-15-15 (XOF 19,500/50 kg) and NPK4-1-6+Oligo element (Zn) (liquid) (XOF 3,000/L). According to the officer in charge of rice cultivation at CALLIVOIRE, NPK4-1-6+Oligo element (Zn) is effective in improving rice quality and production. The stores visited during this survey did not sell NPK12-24-18 recommended by CNRA. Similar to seeds, no subsidy program for farmers to purchase fertilizers was confirmed as of September 2021.

6.6.3. Organic fertilizers

In Cote d'Ivoire, some organizations locally produce organic fertilizers. For instance, the Cellule Universitaire d'Expertise et de Conseil pour le Developpement Agricole (CUECDA) [234] produces organic fertilizers from native trees and other materials. Their organic fertilizer plant is located in Anyama, a suburb of Abidjan, and the products are distributed to agricultural input shops in Abidjan, Yamoussoukro, Daloa, and others. There is only one type of solid organic fertilizer (wholesale price: XOF 8,500/25 kg). Meanwhile, there are different types of liquid organic fertilizers (wholesale price: XOF 10,000/L) available for different crops, such as food crops, cocoa, fruit trees, cotton, and palm. Liquid organic fertilizers for food crops (including maize) can be used for rice cultivation. Since September 2021 was the rice-growing season, liquid organic fertilizers for food crops accounted for half of the total sales volume.

Photograph 6-12 Organic fertilizer sold by CUEDA
Source: Photographed by the survey team

AfricaRice is supporting a major Japanese company for conducting a verification test of organic fertilizers for rice cultivation. The cost and duration of the verification test depend on the extent of data available in advance[235].

[231] Includes crops other than rice [WB (2019) AGRICULTURAL SECTOR UPDATE]
[232] WB (2019) AGRICULTURAL SECTOR UPDATE
[233] CNRA (2020) Bien fertilizer le riz pluvial; en Cote d'Ivoire
[234] CUECDA was established as a private fertilizer research institute in 2003, funded by the university. Due to the civil war that started in 2004, the import of fertilizer was banned, therefore CUECDA started research on fertilizer production using domestic raw materials.
[235] Necessary expenses for verification tests by Japanese companies are not disclosed. If sufficient demonstration data is available, the demonstration period can be shortened.

6.6.4. Agrochemicals

In Côte d'Ivoire, 787 insecticides (of which 12 can be used for rice cultivation), 269 (3) fungicides, 749 (183) herbicides, 76 (2) plant growth regulators, 37 (0) nematicides, 23 (0) rodenticides, and 7 (0) molluscicide are commonly used[236]. According to ADERIZ, weed management is one of the major challenges in rice cultivation in Côte d'Ivoire; thus, herbicides are important. The agricultural cooperative contracted by ADERIZ to cultivate CS is provided with herbicides (Garil Power) but not with insecticides and fungicides. A subsidy system for farmers to purchase pesticides was not confirmed.

The pesticides available for rice cultivation sold by D.M.G. (Abidjan) and CALLIVOIRE (Abidjan, Yamoussoukro) are listed in Table 6-8. According to CALLIVOIRE, the use of propanil[237], a selective herbicide ingredient, may be banned in the country within a few years. Therefore, they have started marketing CRYSTAL 280EC as a herbicide without propanil.

Table 6-8 Types, retail prices, and companies of agrochemicals sold in Abidjan, Yamoussoukro

Type	Name	Retail price (XOF)	Company
Herbicides	SAKARIL 432EC	3,000/L	D.M.G.
	HERBASTOP 720SL	3,000/L	D.M.G.
	CRYSTAL 280EC	10,250/L	CALLIVOIRE
	KALACH EXTRA (glyphosate)	3,500/kg	CALLIVOIRE
	KALACH 360 SL (glyphosate)	5,000/L	CALLIVOIRE
	COUNCIL (triafamone, ethoxysulfuron)	NA	CALLIVOIRE
	CALRIZ (propanil, triclopyr)	5,500/L	CALLIVOIRE
	CALLHERBE (2,4D sels d'anime)	3,500/L	CALLIVOIRE
	AMAZONE10WP (pyrazosulfuron-ethyl)	500/15 g	CALLIVOIRE
Insecticides	KTOTAL 35EC	1,500/L	D.M.G.
	PYRICAL (chlorpyrifosethyl)	2,100/L	CALLIVOIRE
	PYRICAL 480EC (chloropyriphos ethyl)	9,000/L	CALLIVOIRE
Fungicide	BANK PLUS	9,550/L	CALLIVOIRE

Source: Survey team

6.7. Advanced agricultural technologies

6.7.1. Drones

In Cote d'Ivoire, drones are increasingly being used for the production of various crops, including sugarcane, maize, and cotton. Agrostat-CI, a start-up company planning to provide drone services for agriculture, cited Investiv, WeflyAgri, and Cote d'Ivoire Drone as competitors in the country. Investiv, established in 2018, uses drones to map farmlands, collect and analyze farmland information, create vegetation index maps[238], spray fertilizers and pesticides, and other purposes. Over the 3 years since

Photograph 6-13 Drone of Investiv

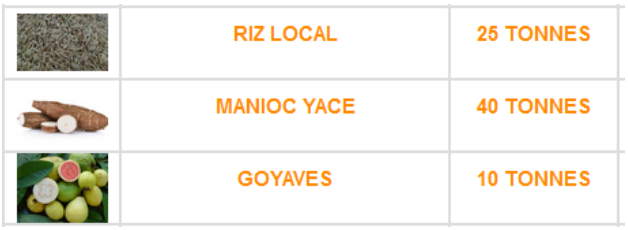
Source: Photographed by the survey team

[236] MINADER (2021) LISTE DES PESTICIDES HOMOLOGUES EN COTE D'IVOIRE AU 31 MARS 2021
[237] A selective herbicide, called DCPA in Japan (https://www.jcpa.or.jp/sp/qa/a4_11.html)
[238] Vegetation index is a measure of plant health. Normalized difference vegetation index (NDVI) is a commonly used measure (https://www.gsi.go.jp/kankyochiri/ndvi.html).

2018, Investiv has provided services for more than 100,000 ha of farmland and to nearly 20,000 producers. Their customers include around 30 companies (institutions), including large agricultural corporations (including OLAM), state-owned enterprises (cotton), agricultural cooperatives, and even research institutions (e.g., CNRA). The company's revenue increased from USD 146,000 in 2018 to USD 600,000 in 2020. In terms of the rice sector, they have partnered with ADERIZ to implement a project targeting the rice basin in the Bandama Valley[239].

6.7.2. Farming support systems

In Cote d'Ivoire, there are several ICT-based farming support companies[240]. ICT4DEV, for instance, provides the following four agricultural applications to farmers and agricultural cooperatives.



Photograph 6-14 Rice sold on Virtual Market

Source: Website of Virtual Market (http://vm.lorbouor.org/)

(1) Farmbook

It is an application that provides technical advice and market information to farmers through text and voice. There is no content for rice, but if requested by customers (such as agricultural cooperatives), content for rice can be created.

(2) GELICO

It is an application that manages information on agricultural cooperative members and monitors their activities. A function to monitor the input volume of fertilizers and pesticides can also be added. The number of registered agricultural cooperatives is 165.

(3) Virtual Market

It is an application that connects producers (agricultural cooperatives) and buyers (restaurants and others). As shown in Photograph 6-24, buyers can examine the crops sold by producers on the web 24 hours a day and call ICT4DEV to get information on the producers they want to contact. The number of registered agricultural cooperatives is 153.

(4) e-Variété

It is an application that provides information on the use of agricultural inputs. Users can also purchase agricultural inputs through this application. The application has been developed but has not been officially launched as yet.

(5) mAgri

Orange, a major telecommunications company, offers an application called mAgri. Farmers can get information on weather conditions or market prices through SMS, call centers, webchat robots, and others[241].

[239] Presentation document provided by Investiv
[240] For instance, ICT4DEV, WeFlyAgri, Orange, and SIFCA [FAO (2020) Digital Agriculture Profile Côte d'Ivoire]
[241] FAO (2020) Digital Agriculture Profile Côte d'Ivoire

6.8. Access to finance

6.8.1. Government-related agencies

ADERIZ

For agricultural finance in the rice sector, ADERIZ is consulting with relevant government agencies, donors, and financial institutions to collaborate in designing financing models, promoting the establishment of funds for program implementation, and training human resources. Some of them are described below.

(1) Leasing of agricultural machinery to service providers

As mentioned earlier, agricultural machinery was purchased as an emergency support measure during the COVID-19 pandemic. The purchase price per unit was reduced by purchasing multiple units at once. The machines will be leased from ADERIZ to agricultural machinery service providers. The lease payment period will be 3–4 years, and no interest will be charged.

(2) Emergency recovery and reconstruction program for rice farming activities in Tonkpi, Guemon, and Cavally régions (Projet d'Urgence de Rehabilitation et de Relance des Activités Rizicoles dans les régions du Tonkpi, du Guemon et du Cavally: PURRAR-TGC)

PURRAR-TGC is being implemented with the support of the West African Development Bank in partnership with the National Federation of Savings and Credit Cooperative Associations (Union nationale des coopératives d'épargne et de crédit: UNACOOPEC-CI, described later). UNACOOPEC-CI will finance the purchase of paddy by rice millers and others. One-third of the loan provided by the cooperative is guaranteed by the program's fund[242] (total amount of XOF 620 million, or 122.52 million yen).

(3) Rice Emergency Program (Programme d'urgence riz)

The Rice Emergency Program was launched in 2020 to support the agricultural export and food production sectors affected by COVID-19. This program is being implemented in partnership with Banque Populaire. The total budget for the program is XOF 750 million (148.22 million yen), of which XOF 500 million (98.81 million yen) is from government-budgeted funds and XOF 250 million (49.41 million yen) is a loan from Banque Populaire. Through this program, Banque Populaire provides loans to rice millers and distributors for the purchase of paddy. ADERIZ verifies the authenticity of documents submitted to the bank by loan applicants and provides information on rice millers, distributors, and other sectors[243].

6.8.2. Commercial banks

According to an agricultural financier from ADERIZ, commercial banks are generally not active in lending to the agricultural sector and they only target the cash crop sector, such as cocoa. Reasons cited included the risk of loan losses due to unstable agricultural profits caused by climate change, inability of borrowers to provide sufficient collateral, and lack of sufficient data to make credit decisions.

(1) Banque Populaire

Banque Populaire has set up a department dedicated to agriculture, which will focus on financing the agricultural sector, including the rice sector, starting in 2021. As of 2021, the agriculture sector accounted

[242] The fund is set up in the Banque National d'Investissement (BNI).

[243] Ministère de la Promotion de la Riziculture, ADERIZ (2020) Expérience de financement des acteurs dans le cadre de la mise en œuvre du projet de promotion de riz local (PRORIL) et mécanisme de financement adosse au fonds de soutien dans le cadre du Programme d'Urgence Riz 2020

for 15% of the portfolio, and the budget for agriculture sector lending was XOF 10 billion (1.9 billion yen), with the goal of increasing the value to XOF 20 billion (4 billion yen) by 2022. The bank has developed a loan scheme for working capital and another loan scheme for capital investment (including the purchase of agricultural machinery) and planned to start providing loans by October 2021.

Table 6-9 Loan schemes developed by Banque Populaire

Loan scheme for working capital	➢ Eligibility: Exporters in the agricultural sector, including the rice sector, or agricultural corporations and associations with export licenses ➢ Use of loan: Working capital, purchase of raw materials ➢ Annual interest rate: 8%. ➢ Repayment period: 6–12 months (depending on crop) ➢ Collateral: 20–25% of the requested loan amount ➢ Maximum loan amount: XOF 8 billion (1.6 billion yen)
Loan scheme for capital investment	➢ Eligibility: Agricultural corporations and farmer associations ➢ Loan use: Purchase of agricultural machinery, capital investment ➢ Annual interest rate: 7.5–8.5% ➢ Repayment period: 3–5 years ➢ Collateral: 20–25% of the requested loan amount ➢ Maximum loan amount: To be determined

Source: Prepared by the survey team based on interviews with Banque Populaire

As of September 2021, over a dozen companies, including exporters, had already applied for loans for working capital. The bank's interest rate for the above two loan schemes is 7.5–8.5%, which is lower than that set by most commercial banks in Cote d'Ivoire (10.75–22%)[244].

(2) Others

The NSIA Bank and Société Ivorienne de Banque provide loans for the purchase of rice-related agricultural machinery. Loans are provided to agricultural corporations or cooperatives but not to individual farmers. There are conditions, including the provision of collateral equivalent to the requested loan amount, such as buildings, land, and agricultural machinery, and other necessary documents to be presented before a decision is made on whether the loan can be granted. Loan limits and interest rates vary depending on the amount of assets that can be provided as collateral, crop (cash crop or not), and level of risk.

Photograph 6-15 Irrigation system (sprinkler) installed by a private seed production company

Source: Survey team

The Société Général bank also provides loans to agribusinesses. XOF 1.9 million (380,000 yen) was loaned to a private seed production company at 12% annual interest for the purchase of irrigation equipment and tractors[245]. Meanwhile, according to this seed production company, the loan application process was very complicated, requiring the submission of many documents, and as the bank's staff was not knowledgeable in the agricultural field, they took a year to review the loan application. In addition to Société Général Bank, the company has also received a loan of XOF1 million (200,000 yen) at 35% interest from COFINA Côte d'Ivoire, MFB[246].

[244] Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO) (2020) Conditions débitrices appliquées par les établissements de crédit de l'UMOA au titre du premier semestre 2020

[245] The repayment period is 5 years. The company found it difficult to repay the loan on time and applied to Société Générale Bank for a 1-year extension of the repayment period.

[246] The repayment period is 8 months and the interest rate is 35% per 8 months. Repayment is in a lump sum.

6.8.3. Microfinance banks

(1) UNACOOPEC-CI

UNACOOPEC-CI, as mentioned above, is an MFB with 136 branches across the country[247]. The bank provides loans to the agricultural sector, including the rice sector, which accounts for 20% of their portfolio. The main beneficiaries of the loans are producers, processors (including rice millers), distributors, and agricultural machinery service providers, and the loan terms are summarized in the table below.

Table 6-10 Loan Scheme of UNACOOPEC-CI

Beneficiaries	Producers	Processors (including rice millers)	Distributors	Agricultural machinery service providers
Loan purpose	▪ Purchase of inputs ▪ Machine service fees for production, harvesting, and post-harvest processing	▪ Purchase of rice paddy ▪ Sales of white rice ▪ Working capital	▪ Purchase of white rice	▪ Working capital
Maximum loan amount	XOF 1 million (200,000 yen)	XOF 60 million (11.85 million yen)	XOF 60 million (11.85 million yen)	XOF 60 million (11.85 million yen)
Loan period	6 months	6–12 months	12 months	Depends on the type of contract with the producer, miller, and distributor as well as the crop
Interest rate	1.5%/month	1%/month	1.5%/month	1.5%/month
Collateral	▪ 10–20% of the loan amount (10–20% for individual farmers, 10% for cooperative members) ▪ Contract with rice millers (without a contract, the loan is not available)	▪ 10–20% of the loan amount (10% for equipment owners, 10–20% for renters) ▪ Contract with distributors (without a contract, the above rate of collateral is 30% of the loan amount)	▪ 10–20% of the loan amount; varies depending on risk. ▪ Contract with rice millers (without a contract, the above rate of the collateral is 20% of the loan amount)	▪ 10-20% of the loan amount ▪ Contract with the producer, miller, or distributor (without a contract, the above rate of the collateral is 20% of the loan amount) ▪ For initial loans, various documents are required, such as proof of business performance.

Source: Prepared by the survey team based on interviews with and materials provided by UNACOOPEC-CI

UNACOOPEC-CI does not provide loans for the purchase of expensive agricultural machinery or capital investment that exceeds the loan limit as it does not have sufficient loan resources and, with a longer repayment period, there is a higher risk of loan default. Nonetheless, loans for the purchase of agricultural machinery are available as long as they are within the loan limit and can be repaid within the repayment period. As of September 2021, new loans were temporarily suspended due to the low repayment rate in the rice sector.

UNACOOPEC-CI participates in PRORIL2 and provides loans to PRORIOL2 beneficiaries for the

[247] UNACOOPEC-CI, Financement des acteurs de la filière riz

purchase of agricultural inputs. The beneficiaries are not required collateral. This is because they have been selected based on the conditions set by the project and are considered to be at low risk of default due to the technical assistance they are receiving.

(2) ADVANS

ADVANS's total financing for the agriculture sector in FY2021 was XOF 16 billion (3.2 billion yen), representing 20–25% of their portfolio. ADVANS mainly finances the cocoa and cashew nut sectors, with cocoa accounting for 95% and cashew nuts for 5% of the total loans to the agricultural sector. Loans for the purchase of agricultural machinery are also provided, with amounts ranging from XOF 10 million to XOF 300 million (1.98–59.29 million yen)[248]. Regarding challenges of financing the rice sector, ADVANS pointed out that although there are agricultural cooperatives, they are not well organized, rice millers do not have proper rice milling machines, and rice millers themselves do not monitor their business, resulting in lack of data and materials to assess risks.

6.9. AFICAT establishment policy (draft)

Based on the survey results, the following draft policy for the establishment of AFICAT is proposed by the survey team:

6.9.1. Basic policy for the establishment of AFICAT (draft)

During the field survey, the survey team held individual discussions with DMEME of MINADER, former officials of the Ministry of Rice Promotion, ADERIZ, ANADER, and CFMAG and received positive responses regarding the establishment of AFICAT.

In Cote d'Ivoire, AFICAT will be implemented in collaboration with PRORIL2. When the survey team discussed with DMEME regarding consistency with the existing policy, it was clarified that the plan of new initiatives or projects must be approved by the government; however, if it is linked to PRORIL2, which has already been approved, no further approval is required. The following ways of collaboration between PRORIL2 and AFICAT are proposed:

- Activities of PRORIL2 and AFICAT should be complementary and should be effectively and efficiently coordinated. To make clear the responsibilities of both projects, the activities of PRORIL2 [Project Design Matrix (PDM)] and AFICAT should be clearly separated.
- Accordingly, AFICAT's activity plan will be implemented by assigning separate AFICAT experts and local staff (that is, AFICAT's activities will not be entrusted to PRORIL2 experts and CPs).
- Meanwhile, AFICAT's activities should be shown to external parties including the government of Cote d'Ivoire and Japanese companies as "JICA's support for the promotion of mechanization" together with PRORIL2.
- In terms of agricultural machinery-related activities, PRORIL2 will conduct verifications and demonstrations of agricultural machinery that is expected to be used immediately in the country, while

[248] The annual interest rate is 15–20%; the repayment period is 24–36 months; and the collateral is 20% of the loan amount or agricultural machinery cost. The repayment rate is 97–100%. ADVANS also provides loans for the purchase of inputs, with annual interest rates ranging from 14% to 16%, repayment periods of 10 months, and loan amounts ranging from XOF 2.5 million to XOF 33 million (490,000–652,000 yen). The repayment rate is as high as 90–95%. In some cases, the Swiss company guarantees the full amount of the loan for the purchase of inputs, and in other cases, it guarantees 25% of the loan amount.

AFICAT will support verifications and demonstrations of agricultural machinery that Japanese companies wish to promote in the country, taking into account the medium-to-long-term perspective.

- The office of PRORIL2 can be shared with the AFICAT team. Regarding the storage of agricultural machinery, the site where the PRORIL2 office is located and the seed warehouse of ADERIZ in Yamoussoukro are possible sites, which will continue to be examined by the AFICAT team.
- To implement AFICAT, its plan must once again be clarified to the local government agencies, such as MINADER (mainly DMEME), ANADER, and ADERIZ, and a consensus must be reached. ANADER will be the point of contact for formal documents with AFICAT on cooperation with CFMAG.

6.9.2. Candidate institutions/locations for collaboration with AFICAT (draft)

As mentioned above, AFICAT will operate in cooperation with PRORIL2, and it is necessary to promptly share information on the specifications and operational status of Japanese agricultural machinery to be introduced by PRORIL2 and ADERIZ. Therefore, the project office of PRORIL2 located in Yamoussoukro will be the base of AFICAT activities. As the PRORIL2 progresses and Japanese companies become interested in expanding their activities, AFICAT activities will be expanded to fields near Buakye, CFMAG in Grand Lahou, Institut National Polytechnique Félix Houphouët-Boigny (INPHB), and AfricaRice, in addition to Yamoussoukro.

Figure 6-8 Candidate institutions/locations for collaboration with AFICAT (draft)

6.9.3. Proposed seven functions of AFICAT

In PRORIL2, Japanese agricultural machinery will be introduced, verified, and demonstrated. Human resource development on agricultural machinery and cooperation with financial institutions are also included in the activities of PRORIL2, which overlaps with AFICAT activities. As mentioned above, the plans of PRORIL2 and AFICAT are complementary, and it is desirable that they work together effectively and efficiently. Based on this, Table 6-11 summarizes the possible collaboration between AFICAT and PRORIL2. Specifically, the expected inputs from PRORIL2 and AFICAT's proposed activities based on these inputs are described. The table also includes AFICAT's own activities (underlined parts).

In particular, AFICAT will consult with the Chief Advisor of PRORIL2, agricultural machinery experts, and international cooperation experts in the field of agricultural machinery each time after the implementation of the AFICAT plan starts. Simultaneously, the information will also be shared with the JICA headquarters and Cote d'Ivoire office.

Table 6-11 Proposed collaboration between PRORIL2 and each AFICAT function

	AFICAT function	Expected input from PRORIL2	AFICAT activities (draft)
1	Advice	▪ Share information that may be useful to Japanese companies, such as baseline survey results, agency information, and financial information ▪ If possible, share reports of experts on surveys conducted by PRORIL2 with the AFICAT team after verification by the CP organization	▪ Information from PRORIL2 will be shared with Japanese companies. At the time, information sources will be clearly indicated (same as below)
2	Exhibition, verification, and demonstration	▪ Share training schedules and other information related to agricultural machinery ▪ Share information from PRORIL2 on the locations of fields where verifications and demonstrations can be conducted by AFICAT and names of related parties, such as agricultural machinery service providers ▪ Share information on Japanese products to be used in PRORIL2, including color sorters and moisture meters, among others, and to be introduced for laboratory use, and their usage status	▪ If requested by the company, AFICAT will organize verifications and demonstrations of Japanese agricultural machinery when training and seminars are held under PRORIL2 ▪ Provide feedback to companies on the use and results of color sorter, moisture meters, among others, installed in the laboratory at PRORIL2 and publicize them (if desired by the companies)

	AFICAT function	Expected input from PRORIL2	AFICAT activities (draft)
3	Verification of the business model and value chain	▪ Share data on the performance of Japanese agricultural machinery to be introduced in PRORIL2 and the actual use of such machinery when loaned/leased to PMEA ▪ Share data on maintenance costs and operation performance, of agricultural machinery that has been or will be introduced to PMEA through ADERIZ	▪ Analyze data on agricultural machinery installed in PRORIL2, share the results with Japanese companies, and publicize the results (if the companies desire) ▪ Demonstrate the performance of Japanese agricultural machinery other than that used in PRORIL2 when requested by Japanese companies ▪ Information on the performance of Japanese agricultural machinery introduced by ADERIZ, such as maintenance costs and work performance, will be shared from PRORIL2, and the results of analysis by AFICAT will be shared with the companies for publicity (if desired by the companies)
4	Finance	▪ Share financial information collected by PRORIL2 and the status of development of financial products as appropriate through reports or interviews with financial experts	▪ Share financial information with Japanese companies when necessary
5	Innovation lab	▪ Analyze rice ingredients and other parameters using inspection equipment to be introduced in PRORIL2	▪ Introduce stakeholders for research and development (e.g., AfricaRice can conduct verification of agricultural materials for rice; CFMAG can conduct verifications and demonstrations of machinery related to rice cultivation; and CFMAG and INPHB can conduct verification of machinery and materials on local suitability and necessity of improvements)
6	Human resource development	▪ Share training schedule (same as above 2)	▪ Conduct verifications and demonstrations of agricultural machinery at training and seminars conducted by PRORIL2 in response to requests from companies ▪ Training of human resources (local agents, agricultural machinery operators, mechanics, and others) as requested by companies
7	Public relations	▪ Share PRORIL2 activities and results of agricultural machines and business models occasionally demonstrated in PRORIL2	▪ Publicize the results of PRORIL2 and AFICAT verifications after discussing with the companies concerned about information that will be useful for promoting Japanese agricultural machinery

Note: Activities unique to AFICAT are underlined.

6.9.4. Needs for machinery from Japan and challenges for Japanese companies to enter the SSA market

Agricultural machinery

- Agricultural mechanization in the rice sector is not very advanced, and there is large room for mechanization. Although Japanese agricultural machinery is well known to some government

officials due to the introduction of Yanmar and Kubota products in the past through grant aid, it is not well known to the general public.

- In PRORIL2, agricultural machinery, including Japanese equipment, will be introduced and their local suitability and profitability will be examined. When these are confirmed, the results will be publicized through AFICAT, which will help raise the profile of Japanese products.
- As a countermeasure against COVID-19, ADERIZ received a budget for the purchase of agricultural machinery and introduced some agricultural machines of Japanese manufacturers, which is considered to be a good opportunity to improve brand recognition of Japanese agricultural machinery. Since ADERIZ will be in charge of monitoring the results of this measure, AFICAT will also pay strong attention to it. AFICAT will strengthen public relations when the superiority and profitability of Japanese products are demonstrated through PRORIL2 and ADERIZ.

Chapter 7. AFICAT Establishment Policy (draft)

Based on the results of interviews with relevant parties, including Japanese companies, field surveys, and discussions with JICA, the following overall concept and short-to-medium-term and long-term activities are proposed for the establishment of AFICAT. While drafting the proposal, it is considered that the roles of AFICAT are to "promote the introduction of advanced technology and agricultural mechanization for contributing to the improvement of agricultural productivity and quality of agricultural products in SSA, where agricultural mechanization is lagging" and to "support Japanese agricultural machinery manufacturers to get a foothold in SSA". Regarding the latter, the role and needed functions/activities of AFICAT have been examined and proposed taking into account the main issues that Japanese agricultural machinery manufacturers face when they expand their business in SSA.

7.1. Overall concept for the establishment of AFICAT (draft)

The basic policy shall be as follows.

1) AFICAT's activities will be planned in the short, mid-, and long term.
2) AFICAT will simultaneously operate in East and West Africa.
3) AFICAT will serve seven functions.
4) Resources for AFICAT operations will be born between the public and private sectors.
5) Japanese companies will be supported to promote their products.
6) AFICAT will contribute to development issues, strengthen the capacity of local government officials, and promote sustainable development in recipient countries.
7) AFICAT will seek opportunities to collaborate with JICA projects, such as grant aid projects, and procurement of equipment and materials through technical cooperation projects.
8) AFICAT will consider establishing AFICAT secretariat and AFICAT hub countries.

7.1.1. AFICAT's activities will be planned in the short, mid-, and long term

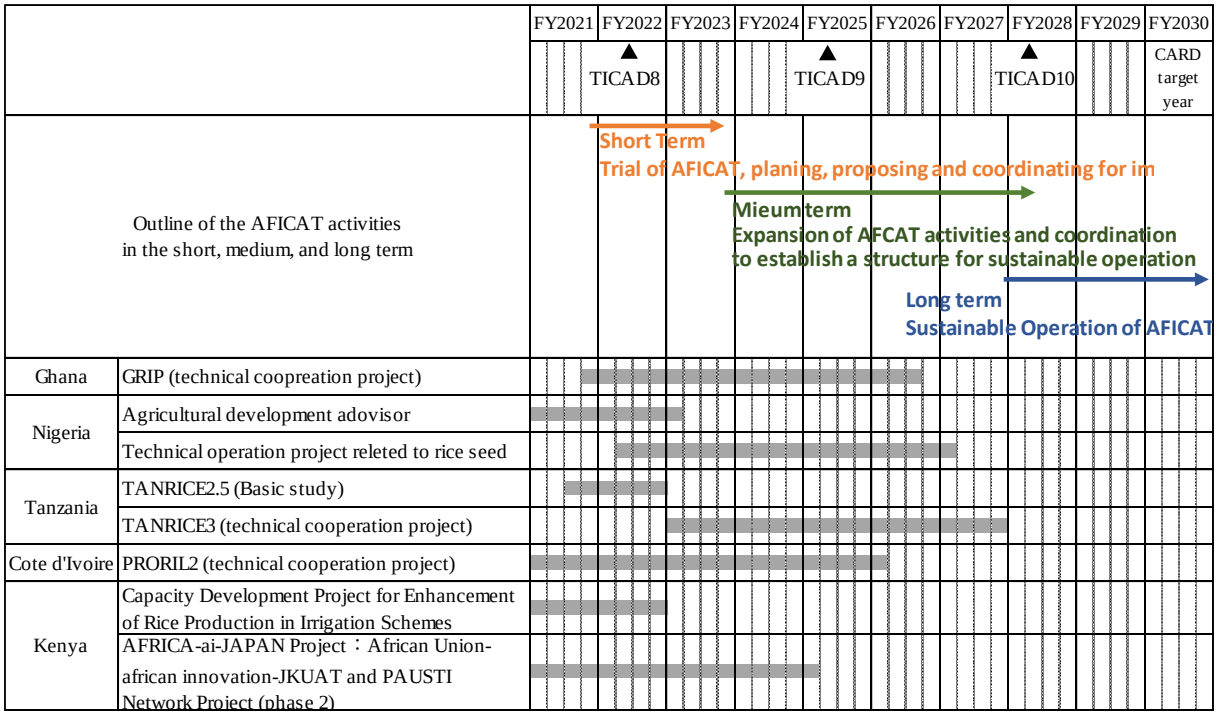
(1) Objectives of the short-, mid-, and long-term activities

AFICAT was announced at TICAD7 as a new initiative to be undertaken through public–private partnership. To achieve this, the steps for confirmation of the local suitability and usefulness of the products, technologies, and services provided by Japanese companies, followed by their dissemination and acceptance in SSA countries, will be taken. To implement this project, the AFICAT plan will be formulated, monitored, and reviewed at each step while carefully assessing the intentions of Japanese companies and relevant organizations in SSA.

Accordingly, the AFICAT plan will be designed by dividing the activities into short-term, mid-term, and long-term plans. In the short term, AFICAT will be operated on a trial basis for approximately 2 years starting in the first half of 2022, and the knowledge and experiences gained from the trial operation will be accumulated for mid-term operation. In the mid-term, while confirming the suitability and usefulness of as many products and technologies of Japanese companies as possible, products and technologies that have been proven successful will be gradually disseminated. Specifically, the five target countries of this survey will be selected as key countries for AFICAT, and the number and range of the functions of AFICAT, locations of its activities, and number of products and technologies introduced will be gradually increased. In the long term,

it is expected to develop a structure in which AFICAT can be operated in sustainable manner. Table 7-1 presents an overview of AFICAT activities in the short, mid-, and long term.

Table 7-1 Outline of AFICAT activities in the short, mid-, and long term



The major milestones and status of AFICAT activities expected at that time are summarized in Table 7-2.

Table 7-2 Major milestones and status of AFICAT activities expected

Milestone	Status of AFICAT activities expected
August 2022 TICAD8 (planned)	▪ AFICAT is launched in the key countries in East and West Africa ▪ Some Japanese companies are participating in AFICAT
2025 TICAD9 (planned)	▪ AFICAT activities continue in the key countries in East and West Africa ▪ Expansion of AFICAT activities to other parts of the key countries and neighboring countries begins
2028 TICAD10 (planned)	▪ AFICAT activities continue in the key countries of East Africa and West Africa. AFICAT activities have spread to the neighboring countries. ▪ AFICAT activities are established in the key countries and are being implemented in a sustainable manner.

(2) Targets of the short-time plan

As momentum and consensus for the implementation of AFICAT have been formed at TICAD7, AFICAT is expected to receive materials and equipment from Japanese companies and start its activities by the beginning of FY2022 at the latest to show the progress of AFICAT by next TICAD. Meanwhile, the results of this field survey revealed the necessity to confirm the capacity of relevant local organizations for promoting AFICAT activities. Therefore, it is proposed that AFICAT activities be implemented on a trial basis in five key countries and the results and experiences be compiled.

Most Japanese companies do not have a good grasp of information on SSA countries, and the targets for specific countries are not clear. Therefore, it is necessary to centralize the contact point for AFICAT activities with companies, accumulate information, modify the contents of activities in each country according to the interests and needs of Japanese companies, and create a structure that allows companies to devise individual activity plans.

Regarding the duration of activities, approximately 2 years should be appropriate because it is considered necessary to experience at least two seasons to work through a series of agricultural activities from production to post-harvest processing.

(3) Activities in the mid-term

A structure in which AFICAT can be operated in a sustainable manner will be established based on experiences from the short-term activities. The seven functions of AFICAT will be activated to confirm the suitability and usefulness of as many Japanese companies' products and technologies as possible, and AFICAT will support local governments and Japanese companies to disseminate verified products and technologies. The five target countries of this survey, namely Ghana, Nigeria, Tanzania, Cote d'Ivoire, and Kenya, will be designated as the key countries of AFICAT. The number of AFICAT functions, target locations, and target products will be increased and expanded.

(4) Options of long-term management structure for AFICAT

At present, the following options are considered for the long-term management of AFICAT. Ideally, AFICAT should be managed by Japanese companies, local agencies, or government agencies without support from donors, such as JICA. Such point of view will also be examined through AFICAT activities in the short and mid-term.

1) Assign an AFICAT promotion advisor for each country

AFICAT promotion advisors will be dispatched to the countries that have agreed to assign AFICAT promotion advisors, who will be responsible for AFICAT management. If AFICAT advisors are to be dispatched to more than one country, the activities can be combined into a multi-country technical cooperation project. By allocating this function to the agricultural policy advisors dispatched to each country, JICA's input can be gradually reduced.

2) Implement AFICAT activities through technical cooperation projects

As shown in Table 7-3, the following ways are envisioned for implementing AFICAT activities through technical cooperation projects.

Table 7-3 AFICAT activities and benefits/challenges through technical cooperation projects

	Technical cooperation project	Benefit and challenges
1	Formulate and implement AFICAT-promoting projects	▪ Project goals and objectives can be matched to AFICAT's goals and objectives. ▪ It is unclear to what extent the local government will accept the inclusion of the promotion of Japanese companies in the project framework.
2	Incorporate AFICAT components into projects related to agriculture and agricultural mechanization (technical cooperation projects, such as rice-related and SHEP	▪ Since AFICAT covers the entire value chain, there is a high possibility that the scope and activities of AFICAT will be limited according to the project goals and scopes. ▪ Modifications are essential to determine whether to include all countries or limit the number of countries in which Japanese companies are interested.

	Technical cooperation project	Benefit and challenges
	projects)	▪ Ways to ensure the coherence and consistency of AFICAT as a whole must be considered.

3) JICA will bear the operational costs in cooperation with local organizations that implement AFICAT activities

JICA will provide seed money, which will be used as a base to build a structure that can generate operating costs for maintaining AFICAT functions. J-Methods Farming, which is being implemented by the Ministry of Agriculture, Forestry and Fisheries of Japan in India, and Golden Valley Agricultural Research Trust (GART) in Zambia, can serve as the reference. This option could be incorporated into the activities of AFICAT promotion advisors mentioned above.

In Zambia, the Agricultural Knowledge and Training Centre (AKTC), which is under the GART, a research institution run based on public–private partnership, is supported by the German government. With this support, AKTC is conducting verifications and demonstrations of agricultural machinery from German companies. Figure 7-1 shows the organizations involved and their roles in the AKTC project.

Likewise, for AFICAT, it is proposed to discuss with the local government whether it is possible to raise the necessary operating costs to maintain the functioning of AFICAT through profits from crop and other sales[249].

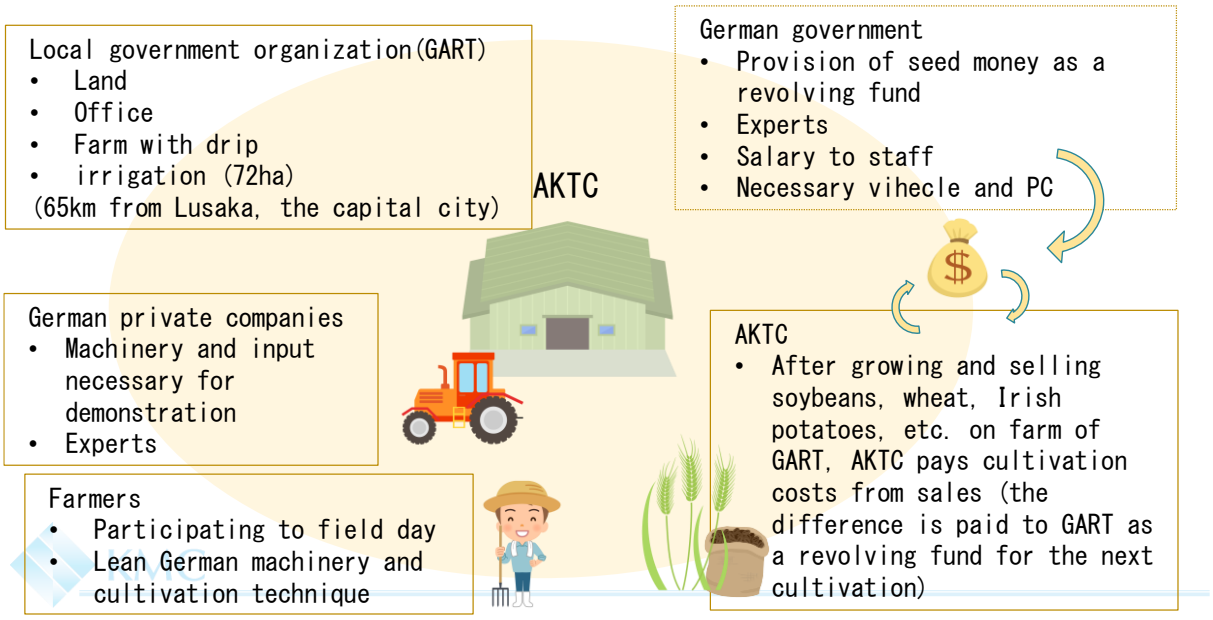


Figure 7-1 Roles of stakeholders in the GART/AKTC project in Zambia

7.1.2. AFICAT will simultaneously operate in East and West Africa

For AFICAT to provide solutions for various challenges in agricultural mechanization, it is important to encourage as many Japanese companies as possible to participate in AFICAT. Furthermore, it is desirable to operate AFICAT in several countries in SSA, specifically in East and West Africa, which are

[249] In Côte d'Ivoire, for example, it was confirmed that CFMAG are using part of the profits from crop sales and agricultural machinery service fees to cover CFMAG operating costs.

geographically and culturally diverse.

The concept of AFICAT was generally positively received by the local government agencies in the four countries where the field survey was conducted: Ghana, Nigeria, Tanzania, and Cote d'Ivoire. Although Kenya is no longer a target country of this survey, it will continue to be a key country for AFICAT and the possibility of starting AFICAT activities there will be considered given the high interest of Japanese companies.

7.1.3. AFICAT will serve seven functions

As described in Chapter 2, based on the results of interviews with Japanese companies, the seven functions of AFICAT were revised as shown in Figure 7-2, and through field surveys in four countries, these functions were confirmed to be necessary for Japanese companies to enter the SSA market.

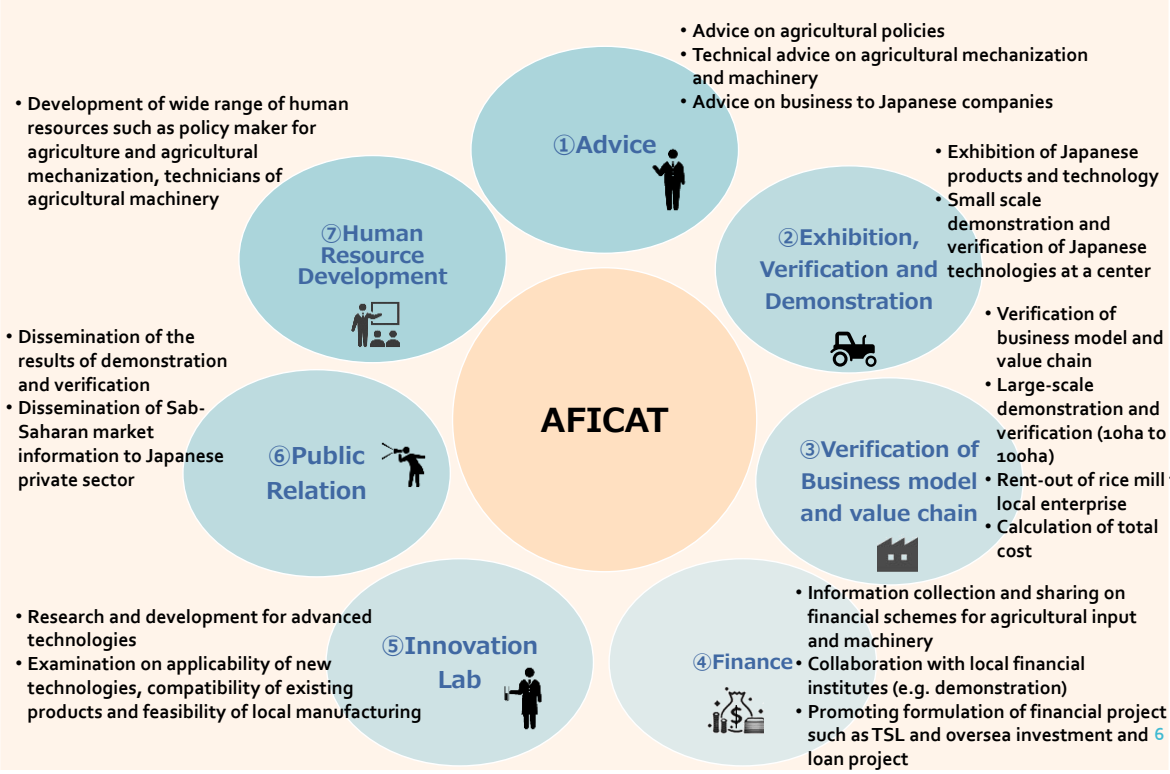


Figure 7-2 Revised seven functions of AFICAT (reprinting Figure 2-4)

Considering the seven functions of AFICAT, requirements for the selection of AFICAT sites are summarized in Table 7-4. In terms of exhibition effectiveness, it is desirable to have good accessibility, such as distance from the capital and/or major cities as well as international airports. In terms of the sustainability of AFICAT, it is desirable that the roles of candidate institutions in the country and the functions and activities envisioned for AFICAT are coincided.

Table 7-4 AFICAT's seven functions and selection criteria for the site

	Site for (1) advice, (4) finance, (6) public relations, and (7) human resource development	Site for (5) Innovation lab	Demo. plots for (2) exhibition, verification, and demonstration and (3) verification of the business model and value chain	Demo. plots (post-harvest) for (2) exhibition, verification, and demonstration and (3) verification of the business model and value chain
Site conditions	▪ Easy access to the capital and/or major cities as well as international airports ▪ Good transportation, such as proximity to the major roads ▪ Not very unsafe	・(Same as left)	▪ Located in major rice production areas ▪ Easy access to the capital and/or major cities as well as international airports ▪ Good transportation, such as proximity to the major roads ▪ Feasibility of transporting agricultural equipment from the innovation center and other locations ▪ Not very unsafe	▪ Easy access to the capital and/or major cities as well as international airports ▪ Good transportation, such as proximity to the major roads ・For large-scale rice milling equipment, there should be some local companies to cooperate with demonstrations.
Necessary resource	▪ Plots larger than a certain size (1–2 ha or larger) ▪ Plots with existing drainage canals or where canals can be constructed for the introduction of agricultural machinery ▪ Storage space for machinery and spare parts as well as space for machine maintenance is available or can be constructed ▪ Space for exhibition is available or can be constructed ▪ Human resources (researchers, operators, and laborers) necessary for demonstration are or will be available.	▪ Laboratory has personnel in charge of research and development. ▪ As a laboratory, there are facilities that can or will be provided. Alternatively, land to build a laboratory is provided.	▪ Plots larger than a certain size (approx. 10 ha). ▪ Plots are or will be prepared for the introduction of agricultural machinery, such as field plots and drainage canals, in consideration of workability. ▪ The land is owned by farmers who are interested in new technologies and who are willing to cooperate with AFICAT.	▪ For large-scale rice milling equipment, there is place to store it, and it is able to collect enough rice for milling. ▪ Local companies that lease rice milling equipment are allowed to open their facilities to the public for demonstrating their usability, maintenance, and adjustment methods.
Human resource development	▪ Facilities such as classrooms, chairs/desks, accommodation, blackboards, screens, and projectors necessary for human resource development are or will be	▪ (Same as left)	▪ Managers/farmers who own farmlands and are willing to adopt new technologies.	▪ Owners or managers of equipment are willing to introduce new technologies.

	Site for (1) advice, (4) finance, (6) public relations, and (7) human resource development	Site for (5) Innovation lab	Demo. plots for (2) exhibition, verification, and demonstration and (3) verification of the business model and value chain	Demo. plots (post-harvest) for (2) exhibition, verification, and demonstration and (3) verification of the business model and value chain
	available.			
Others	▪ The role of the organization coincides with the activities of AFICAT. ▪ It is desirable if the site is related to a JICA project.	▪ (Same as left)	▪ It is desirable if the site is related to a JICA project	▪ (Same as left)

7.1.4. Resources for AFICAT operations will be born between the public and private sectors

AFICAT is expected to operate in a sustainable and self-sustaining manner in the long term, requiring a high level of commitment from all parties involved in its operation. It is assumed that the basic resources, such as land and personnel, will be provided by SSA's local governments. To ensure it, AFICAT will intend to involve the relevant local organizations by actively providing information on Japanese companies and the results of verification of their products and technologies.

Japanese companies are expected to provide products to be used in the exhibition, verification, and demonstration and to bear the cost of dispatching engineers as required. The Japanese government and JICA are expected to assist in the rehabilitation of buildings, if required, and to provide personnel and necessary inputs, particularly for a certain period until AFICAT is fully operational. Table 7-5 summarizes the proposed resource burden for AFICAT operation.

Table 7-5 Resources for AFICAT operations provided by each stakeholder (draft)

		Government and private sector in SSA	Japanese government/JICA	Japanese companies
1	Land and building	◎	○ Rehabilitation of facilities and farmlands	-
2	Human resources	◎	△	○ Dispatchment of Japanese technicians or staff of local dealers
3	Agricultural machinery	○ Machinery to be used for rice production.	△	◎ Provision of machinery for exhibition, verification, and demonstration
4	Agricultural materials	○ Materials to be used for rice cultivation	△	◎ Provision of materials for exhibition, verification, and demonstration
5	Operation cost (fuel/facility maintenance)	◎	△	-

Note: ◎: mainly provided; ○: partially provided; △: provided for a certain period until AFICAT is fully operational.

At AFICAT, it will be possible to conduct verifications and demonstrations of Japanese companies'

products that have already been introduced in the country. For instance, in the case of large agricultural machinery, such as tractors and combine harvesters, some companies consider it huge burden to provide products exclusively for AFICAT. In addition, even if they bring their products to AFICAT, arranging storage and display space for these will require time; thus, machines that have already been delivered to the site can be used.

7.1.5. Japanese companies will be supported to promote their products

AFICAT aims to promote agricultural mechanization in SSA by disseminating the products and technologies of Japanese companies. During AFICAT activities, such as exhibition, verification, and demonstration of its products, Japanese companies are expected to establish a local sales and maintenance structure, including the supply of spare parts. AFICAT will provide Japanese companies with relevant local information and potential distributors to help them establish such a structure within a short period. AFICAT will also provide advice, taking into account the major issues that companies face when expanding their business in SSA, such as identifying proper distributors and understanding legal matters and business practices related to importing products and hiring local personnel.

As pointed out in the preceding survey, although many agricultural machines have been provided to SSA by JICA through grant aid, including 2KR, this unfortunately did not much aid Japanese companies in promoting their products for sale and entering the SSA market. One of the main reasons for this was that the products were introduced without any after-sales service structure in place, such as the absence of sales agents on site. Some Japanese companies pointed out that there was a mismatch between their business strategies and the products introduced through grant aid projects. AFICAT must serve as a bridge between JICA projects, including grant aid, and Japanese companies.

AFICAT, as a neutral third-party organization, will work with local government officials to analyze the results of verifications and demonstrations of Japanese products for confirming their superiority in terms of total cost, taking into consideration factors such as service life, maintenance costs, and fuel efficiency. AFICAT will also support the promotion of Japanese companies' products by publicizing verified products and technologies.

7.1.6. AFICAT will contribute to development issues, strengthen the capacity of local government officials, and promote sustainable development in recipient countries

It is expected that AFICAT will eventually be managed mainly by local government agencies and the local private sector in collaboration with Japanese companies. To respect the policies, strategies, and intentions of the local government, to assess the implementation capacity of the local government, and to establish an implementation structure for sustainable operation of AFICAT, it is essential to involve local stakeholders as much as possible from the early stages of AFICAT operation.

In addition, if local stakeholders can proactively promote agricultural mechanization with the private sector, including Japanese and local companies, this can improve productivity and reduce post-harvest losses in the mid- to long-term; in this way, AFICAT can contribute to solve development issues in the agricultural sector.

7.1.7. AFICAT will seek opportunities to collaborate with JICA projects, such as grant aid projects, and procurement of equipment and materials through technical cooperation projects

The Japanese government and JICA are implementing many grant aid projects and technical cooperation projects in SSA. It is expected that the products and technologies of Japanese companies that have been verified and developed by AFICAT will be widely utilized to broaden the impacts of these projects. Accordingly, AFICAT will promptly exchange information with JICA and the Japanese Embassies to promote cooperation between grant aid and AFICAT, as they are providing agricultural machinery and technologies through their grant projects, such as CARD grant projects and embassy's grassroots grant projects.

To promote such cooperation, it is necessary to review the nature of grant aid projects and equipment procurement procedures where possible; for example, the bidders would be requested to submit after-sales services and future business development plans in the procurement process during grant aid and technical cooperation projects.

In many SSA countries, there are very few financing schemes for agricultural machinery. When the products of Japanese companies are popularized to a certain extent in the target countries, financial schemes, such as two-step loans for agricultural machinery and materials, including Japanese agricultural machinery, can be expected. Furthermore, creation of a system to guarantee loans, such as Tanzania's PASS, is expected. Through the field survey, it has been observed that SSA countries vistied are promoting agricultural mechanization in close collaboration with the private sector. AFICAT will also support the implementation of such policies as well as solutions for development issues of the countries by promoting the use of verified products and technologies in collaboration with Japan's other projects.

7.1.8. AFICAT will consider establishing AFICAT secretariat and AFICAT hub countries

(1) Establishment of AFICAT secretariat

As mentioned above, since AFICAT will be established and simultaneously operated in East and West Africa and its activities will span across multiple organizations and locations depending on their functions within a same country, it is necessary to establish a "secretariat" function for overseeing and coordinating all AFICAT activities. According to many Japanese companies, it would be desirable to have a single point of contact for AFICAT, rather than separate points of contact for each country, and activities should be managed in a centralized manner. It is proposed to introduce secretariat under the JICA headquarters.

Collaboration among the Japanese government[250], international organizations[251], and existing public–private partnerships[252] that support Japanese companies in developing countries, including SSA is also expected.

[250] "Science, Technology and Innovation (STI) for SDGs" by the Cabinet Office, "Jump out of Japan" by the Ministry of Economy, Trade and Industry, "J-Methods Farming" and" Public-Private Partnership Agricultural and Rural Development Technology Study Commissioned Project" of MAFF, and JETRO

[251] Sustainable Technology Promotion Platform (STePP) of UNIDO, SHIP (SDGs Holistic Innovation Platform) of UNDP, and others

[252] Global Food Value Chain Public-Private Council of MAFF and Africa Business Council

Figure 7-3 Candidate key countries of AFICAT

(2) Establishment of hub countries for AFICAT

The five key countries are also potential hub countries for the expansion of AFICAT activities in SSA. Considering the economic zones, several groups of priority countries and neighboring countries can be assumed in SSA, as shown in Figure 7-4. In Japan, in addition to JICA headquarters, JICA Tsukuba will be positioned as the base and the possibility of cooperation with AFICAT, particularly in terms of human resource development and exhibition and demonstration of Japanese products, is considered. Accordingly, a suitable structure including SSA and Japan will be examined, and the organizations in charge and their roles in expanding AFICAT activities will be reviewed.

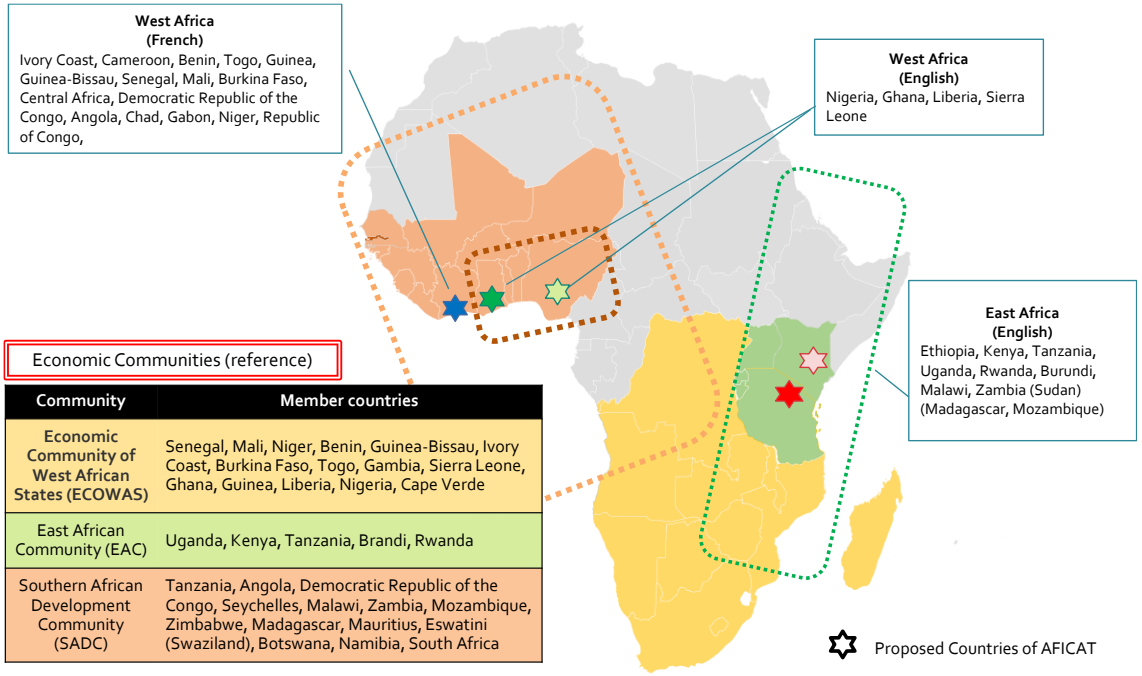


Figure 7-4 Candidate key countries and economic zones in SSA

Table 7-6 AFICAT key countries and their roles in SSA (draft)

	Country	Role
1	Ghana	▪ Demonstration of Japanese products and technologies will mainly be conducted in the KIS. ▪ In addition, Ghana can serve as the base for surrounding English-speaking countries in West Africa and information can be disseminated to the neighboring countries by inviting them to participate in verifications and demonstrations and by collaborating with JICA's specific training program PAMA (overseas supplementary training). Information collection from neighboring countries will be included in the activities (establishment of bases in neighboring countries will be considered depending on the interests of Japanese companies and the local government).
2	Nigeria	▪ Demonstration of Japanese products and technologies will mainly be conducted in FCT and Nasarawa State. However, other locations may be considered depending on the interests of Japanese companies and the local government. ▪ Although the market potential is large, there are security issues; thus, activities will be started on a smaller scale in Nigeria than in other countries. Although it is difficult at this point to establish a base for the expansion of the technology to the neighboring countries, Nigeria will be designated a key country due to its large domestic market.
3	Cote d'Ivoire	▪ Verification and demonstration of Japanese products and technologies will mainly be conducted through PRORIL2. ▪ In addition, Cote d'Ivoire will serve as the base for the French-speaking region of West Africa.
4	Tanzania	▪ Verifications and demonstrations of Japanese products and technologies will mainly be conducted at KATC. ▪ Information will be disseminated to the neighboring countries through collaboration with JICA's subject-specific training program PAMA (overseas supplementary training). Furthermore, since it was agreed in TANRICE 3 that KATC will support CARD 2 by accepting trainees from the neighboring countries for the rice farming training course and that KATC will be a hub to promote mechanization in the agricultural sector, it is expected to become a base for the neighboring countries.

	Country	Role
		▪ Depending on the interests of Japanese companies and the local government, KATC will consider establishing bases in the neighboring countries.

(3) Establishment of a structure for information sharing among AFICAT key countries

Among the four countries surveyed here, Tanzania has a relatively well-developed financial system in terms of loan schemes that can be availed to purchase agricultural machinery, guarantee systems that promote the use of loans for purchasing agricultural machinery, and leases that promote the use of agricultural machinery. In addition, many farmers in Tanzania are replacing the currently used Chinese combine harvesters with Japanese products for paddy harvesting.

To promote similar replacement in countries other than Tanzania, i) suitable fields must be available where the agricultural machinery and materials can be introduced (i.e., irrigated paddy plots of a certain area); ii) the product must be suitable for use under local conditions (e.g., tractors running well even in wetlands with poor drainage); iii) performance of the product must be superior to that of products made in other countries (e.g., greater threshing accuracy and fewer foreign substances); iv) the durability of the product must be higher; v) the cost of using the machine should be lower than the cost of hiring labor; vi) the advantages of the product should be recognized by the buyer; and vii) after-sales service system, such as local dealers and sales agents, must be in place.

The availability of financing or leasing systems for buyers to decide to purchase the products is another factor for promoting agricultural mechanization. It is therefore desirable to create an opportunity to share the case of Tanzania, a relatively advanced country to introduce Japanese products, with other countries where AFICAT will be established. JICA Tsukuba is planning to start the subject-specific supplementary overseas training program PAMA in one of the SSA countries after the training is done in Japan. TANRICE3 will receive trainees from neighboring countries in Tanzania. At CARD meetings, a structure to share information among SSA countries, including AFICAT key countries, should also be established.

7.2. Short-term activity plan (draft)

7.2.1. Policies for implementing activities in the short term

Based on the basic policy of the overall concept that "AFICAT will simultaneously operate in East and West Africa" and that "in the short term, AFICAT will be initiated by the time of TICAD8," the following are proposed as the basic policies for short-term activities:

1) AFICAT will focus on agricultural machinery for rice at first.
2) AFICAT will start with limited locations and functions.

(1) AFICAT will focus on agricultural machinery for rice at first

As the crops change, the local government organizations that work with AFICAT may also change. Since AFICAT is expected to contribute to CARD and rice is one of the crops where Japanese agricultural machinery is strong, AFICAT will start its activities focusing on machinery related to rice.

(2) AFICAT will start with limited locations and functions

Considering the limited time before TICAD8 and the lack of prospects for lifting restrictions on activities due to COVID-19, AFICAT will start on a small scale with a limited number of areas and partner organizations. Among the seven functions, AFICAT will focus on (1) advice; (2) exhibition, verification, and demonstrations; (3) verification of the business model and value chain, and (6) public relations. Thereafter, the number of activity areas and collaborating organizations will be gradually expanded in accordance with the interests of Japanese companies and local conditions.

In terms of public relations, to support Japanese companies in entering the SSA market, it is necessary to introduce AFICAT's products as wide and as soon as possible, and public relations in Japan are essential to popularize AFICAT's activities and encourage more Japanese companies to participate. To obtain information from Japan and other SSA countries, ways to share information on AFICAT activities on the Internet, such as websites and social networking services, must be considered.

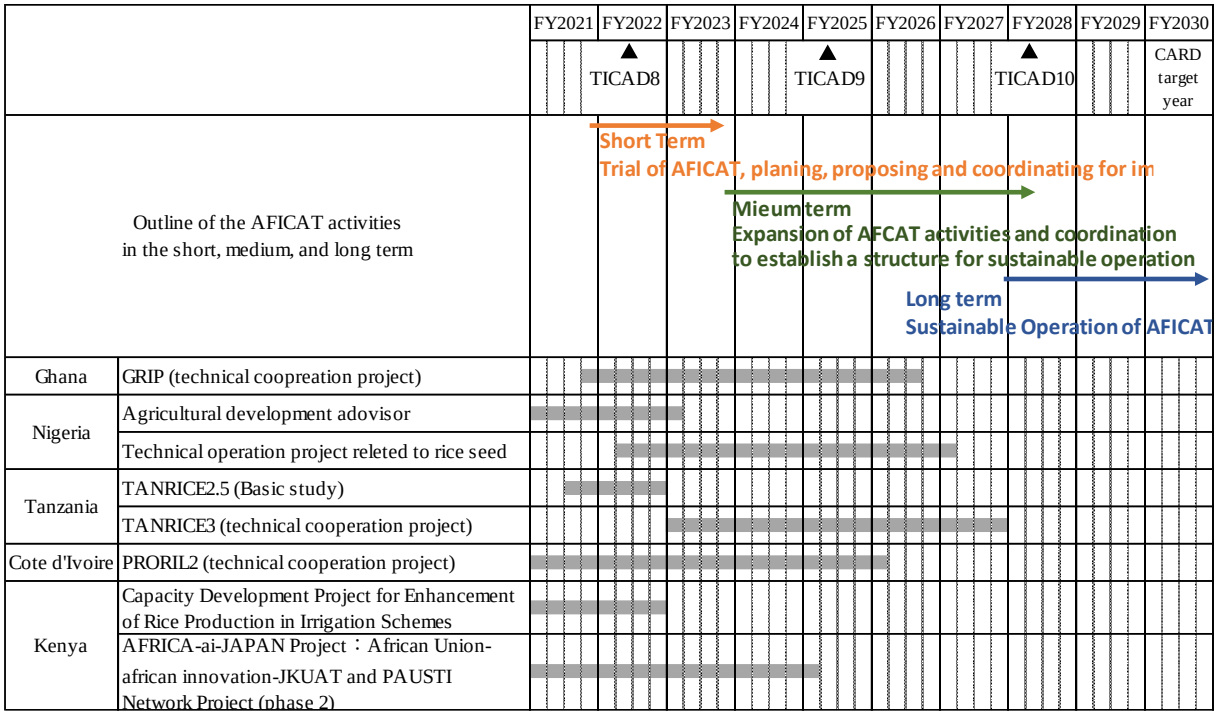
7.2.2. Implementing structure

The AFICAT team should be composed of experts in two fields: agricultural machinery and public–private partnerships. The survey team proposes that experts in agricultural machinery and public–private partnerships will each be in charge of several countries. When AFICAT is set up in each country, it is necessary to stay there for a certain period. It is proposed that the four countries, except Kenya, be proceeded with almost simultaneously and that personnel be assigned to assist the above-mentioned experts in charge.

In the case of simultaneous operation of AFICAT in the four countries, collaborating with the technical cooperation projects already underway as well as experts dispatched (e.g., the Agricultural Development Advisor of Nigeria) will help AFICAT activities. Specifically, Tanzania and Ghana will require sufficient human resources for the launch of AFICAT, while human resources for AFICAT in Nigeria can be limited since by collaborating with the Agricultural Development Advisor who has been dispatched separately and whose mandates include supporting AFICAT. Similarly, human resources for AFICAT in Cote d'Ivoire can be limited by collaborating with the ongoing PRORIL2.

At the early stages of AFICAT, it will be necessary to explain the project plan to the relevant local organizations, obtain their agreement for cooperation, and conclude the agreement documents when necessary. In addition to Japanese experts, it is necessary to assign local government officials or local consultants. For reference, Table 7-7 summarizes the implementation period of JICA projects that are considered to be related to AFICAT.

Table 7-7 Projects underway or planned for implementation in each country and the proposed implementation period of AFICAT activities (draft)



7.2.3. Activities

(1) Collecting basic information

The following information will be collected as basic information. The collected information will be shared individually with companies interested in AFICAT or shared with a wide range of Japanese stakeholders through JiPFA and other occasions for encouraging Japanese companies to utilize AFICAT and enter the SSA market.

1) Trends in agricultural mechanization and rice promotion

Policies and projects related to agricultural mechanization and rice promotion as well as activities of other donors and key stakeholders will be confirmed and monitored.

2) Rice production, major production areas, yield, and cropping pattern

Information on rice production, major production areas, yield, and cropping pattern in each country has already been collected through this survey and other JICA projects; however, AFICAT will sort out the missing information and collect information required by Japanese companies. Regarding cropping pattern, the details of each region will be confirmed in addition to the AFICAT's base location. The collected information will be referred to when formulating AFICAT's activity plan or when Japanese companies inquire about it.

3) Outline of the rice value chain

Information on the overview of the rice value chain, quality standards for rice and paddy, rice prices, and key stakeholders will be collected.

4) Major stakeholders

AFICAT has a wide range of stakeholders, including not only government agencies but also

international research institutes, NGOs, industry associations, agribusinesses, agricultural colleges, and universities. Discussions will be held with each stakeholder to examine the possibility of collaboration with AFICAT and Japanese companies. Collaboration between Japanese companies and local stakeholders will be facilitated by sharing contact information of relevant parties when Japanese companies request.

5) Government agencies locally responsible for product development and improvement

Consultations will be held with organizations that develop and improve agricultural machinery taking local suitability into account, such as CAMARTEC in Tanzania, KNUST in Ghana, and NCAM in Nigeria, to verify the possibility of agricultural mechanization using Japanese companies' products.

6) Information on Crops Other than Rice (priority: low)

Relevant information on major crops other than rice (production volume, major production areas, yield, cropping patterns, and outline of the value chain) will be collected and complied to promote mechanization in the country.

7) Candidate companies for distributors

Information on local companies that may be potential distributors of Japanese products will be collected; if JETRO offices exist, the AFICAT team will cooperate with them to identify potential distributors.

8) Other support for Japanese companies

Information on other schemes related to support Japanese companies, such as the Sustainable Technology Promotion Platform (STePP) promoted by UNIDO Tokyo, will be collected[253].

(2) Encourage Japanese companies to participate in AFICAT

The AFICAT team will hold individual discussions with companies interested in participating in AFICAT and encourage them to join AFICAT. In addition to individual meetings, seminars for Japanese companies will be held to widely motivate companies for participating in AFICAT.

(3) Support for the preparation of activity plans for Japanese companies

The AFICAT team will prepare overall activity plans for AFICAT as well as individual activity plans for Japanese companies. For this purpose, coordination will be made to reflect the intentions of local government organizations and relevant Japanese organizations.

(4) Support for necessary procedures such as the inspection and registration of Japanese products

In some countries, new products must be inspected and registered. Information on these procedures will be collected and shared with Japanese companies as necessary.

(5) Exhibition, verification, and demonstration

Exhibitions, verifications, and demonstrations will be held in each country according to the activity plan of Japanese companies.

(6) Public relations

Information obtained through verifications and demonstrations in each country will be disseminated in two ways: one is directed to stakeholders in SSA in order for them to understand that Japanese products can contribute to agricultural mechanization in the countries concerned, and the other is directed to Japanese companies to encourage them to utilize AFICAT for entering to the SSA market. In the case of information related to individual companies and products, proper information management is essential, and only

[253] http://www.unido.or.jp/activities/technology_transfer/technology_db/

information that a company can release should be disseminated. In the case of public relations, AFICAT team will utilize the services of industry newspapers, such as Shin-Norinsha Co., Ltd., to publicize AFICAT activities. Information on AFICAT will be disseminated at TICAD8 to be held in August 2022.

(7) Coordination with relevant organizations in Japan

1) JICA Tsukuba Center

JICA Tsukuba Center has been promoting the Agricultural Co-Creation Hub concept, which includes opinion exchange meetings between trainees (primarily government officials from developing countries) and Japanese companies as well as the introduction and demonstration of Japanese products and technologies as business matching related to agricultural. Therefore, the introduction of Japanese products handled by AFICAT and business matching between the Japanese companies participating to AFICAT and trainees can be realized at the JICA Tsukuba Center in line with the Agricultural Co-Creation Hub concept. It is desirable that the person in charge of the Agricultural Co-Creation Hub supports these activities. Accordingly, whether JICA Tsukuba Center should be incorporated as part of AFICAT or positioned as a partner needs consideration.

Further, it would be desirable for the JICA Tsukuba Center and AFICAT team to exchange information on a regular basis. For instance, JICA Tsukuba Center can introduce Japanese companies interested to utilize the center for displaying their products to AFICAT. Demonstration and/or verification activities in AFICAT can be conducted by connecting AFICAT and JICA Tsukuba Center. Such activities can be conducted 6 months or a year after AFICAT becomes operational.

For companies that hesitate to initiate the business in SSA, it would be helpful if JICA Tsukuba Center can act as a contact point for SSA and link the trainees from SSA with such companies, thereby reducing the burden on the companies. JICA Tsukuba Center is expected to play a role in providing opportunities to meet trainees, introduce products, and conduct demonstrations for companies wishing to enter the SSA market.

2) JICA public–private partnership program

The survey team recommends cooperation with the Private Sector Partnership Department of JICA, which is charge of the JICA public–private partnership program, through information exchange once or twice a year. For instance, the department can introduce Japanese companies that have been selected for JICA's public-private partnership program to AFICAT and recommend them to utilize it. Alternatively, Japanese companies whose products are verified in SSA with AFICAT can apply to JICA's public–private partnership program to initiate or expand their activities in SSA. In the future, the department may recommend the use of AFICAT in the application guidelines for their public–private partnership program and they can set a priority quota for AFICAT in the year before TICAD, after AFICAT becomes fully operational.

3) JETRO

Cooperation and demarcation with the JETRO local offices was confirmed to be essential in terms of information provision and advice during the field survey. Exchange and discussion with related officials are necessary to ensure close cooperation with JETRO.

4) MAFF

Related projects, such as J-Methods Farming and Public-Private Partnership Agricultural and Rural Development Technology Study Commission Project (Kenya), are being implemented. It is necessary to

coordinate with the ongoing projects.

5) JIRCAS and NARO

Collaboration with research institutes in Japan, such as JIRCAS and NARO, should be considered. In particular, JIRCAS has been conducting research in Ghana and Tanzania using products of Japanese companies. AFICAT team will collaborate with them on the results of their surveys.

6) CARD

The RICE approach promoted by CARD includes upgrading of rice milling equipment in SSA and promotion of mechanization in production. The AFICAT team will discuss collaboration with the CARD secretariat.

(8) Confidentiality with Japanese companies

Each company proceeds their business based on their unique business strategy. It is necessary to clarify the extent to which they are allowed to disclose information, such as whether they are using AFICAT, the specific products they are demonstrating, and the results of their demonstrations. If necessary, a confidentiality agreement should be signed.

(9) Others

1) Indicators for AFICAT activities

To clarify AFICAT's activity policy, it is desirable to set up indicators (KPIs) for AFICAT activities. Indicators related to the perspectives of development assistance and support for Japanese companies entering the SSA market should be set. Tentatively, the following indicators can be considered.

Table 7-8 Indicators for AFICAT activities

Perspective		Indicator (draft)
1	Development assistance	▪ Number of products and technologies that contribute to improving agricultural productivity and profitability verified and/or demonstrated by AFICAT ▪ Capacity development of local government officials (development of the ability to inspect agricultural machinery and conduct verifications and demonstrations) ▪ Capacity development of local dealers (development of the ability to manage operations and provide after-sales services/spare parts)
2	Support for Japanese companies entering the SSA market	▪ Number of companies that have used AFICAT ▪ Number of products and technologies verified by AFICAT ▪ Number of demonstrations conducted by AFICAT and number of participants ▪ Number of companies entering the SSA market and products sold in SSA (growth in sales of Japanese products) ▪ Media exposure

2) Activities in the mid- and long-term

To encourage Japanese companies for utilizing AFICAT, organizing study tours to visit SSA sites can be considered in the mid-to-long term. Events to introduce Japanese companies may be held at local Japanese embassies. Information will be exchanged with local Japanese embassies as appropriate, and collaboration can be sought when related events are held.

3) Others

At TICAD8, it is desirable to organize presentations by Japanese companies that are already selling their products in SSA or are planning to enter the market. AFICAT or JICA should encourage the TICAD8 secretariat and Japanese companies to provide such opportunities, taking into account the interests of Japanese companies.