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Antsirabe, February, 2013

Suismono

Indonesian Expert

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

MinAgri = Ministry of Agriculture

CFAMA = Agricultural Machinery Training and Application Center

JICA = Japan International Cooperation Agency

Papriz = Projet d'Amélioration de la Productivité Rizicole

DGR = Direction du Génie Rural

DGT = Directeur Général Technique

TCE = Third Country Expert

TOR = Term of Reference

RMU = Rice Milling Unit

MIN = Minimum

MAX = Maximum

STD = Standard Deviation

HP = House Power

B/C ratio = Bennefid Cost

I. THE OUTLINE OF THE PROJECT

1.1. Background and content of technical coorperation

Rice is the staple food Madagascar. Therefore, the Ministry of Agriculture in collaboration with JICA Project Madagascar to increase rice production in highland in Madagascar.

JICA Project activities started in 2009 to 2014 (5 years), the activities of "the Project for Rice Productivity Improvement in Central Highland's Madagascar". The Project target area is five regions in Madagascar's Central Highland (Vakinankarata, Bongolava, Alaotra Manggoro, Itasy and Analamanga). These activities helped Expert third countries (Third Country Expert / TCE) to increase rice production in the area.

Efforts to increase rice production not only in terms of farming activities (pre-harvest), but is an integrated activity involving aspects of post-harvest activities and the application of appropriate machinery technology. Paddy losses during postharvest handling is very influential on rice production. Expert contribution on this project is to develop and transfer of technology to reduce loss during post-harvest rice, improving yield and quality of rice, as well as the utilization of by-product of rice milling yield to increase added value. Therefore, it needs postharvest technology improvements and mechanical equipment required.

1.2. Purpose and content of the project

Productivity of rice product increases at model sites of the project.

1.3. Project name, site and goverment agencies involved

- Project name : Project for Rice Productivity Improvement in Central Highland in Madagascar.
- Project site : Five region (Vakinankarata, Bongolava, Alaotra Manggoro, Itasy and Analamanga).
- Goverment Agency : Ministry of Agriculture (MinAgri)
- Counterpart Agency : Agricultural Machinery Training and Application Center
- (CFAMA), in Antsirabe.

TCE akan melaksanakan kerjasama teknik dengan JICA Project tentang " the Project for Rice Productivity Improvement in Central Highland ini Madagascar" di 5 regions (Vakinankarata, Bongolava, Alaotra Manggoro, Itasy and Analamanga).

TCE office in CFAMA – Antsirabe, Vakinankarata. He will visit the five regions to determine the current state of post-harvest grain handling and equipment / machinery being used at the farm level, rice mills, and local manufacturers at the target location. Related to post-harvest handling losses, yield and quality, and utilization of by-product of rice milling.

1.4. Scope of Services to be provided by expert

1.4.1. Inprovement of post-harvest technology

- Investigate present situations of postharvest of rice in central highland of Madagascar
- Resduse postharvest losses and increas grain quality of rice with systematic approach combining the appopriate methods of cutting, threshing, drying, storage and milling.

1.4.2. Field test and data collection of developed machines

- Undertake improvement and engineering performance test of macjine/ tools developed by provious TCEs.
- Undertake field test and data collection for developed machines/tools with farmers and local manufacturers.

1.4.3. Collect information

- Collect information on existing machine / tools.
- Assess needs of farmers in target region.
- Evaluate potentialn mechanization of farmer operations
- Identifying type ands specification of machines / toos to meet their needs.
- Provide technical support on appropriate machinery uses for DRDR (regional stations of (MinAgri) staff and extensiton Agents

II. METHODOLOGY

2.1. Making schedule activity and budget planning

- Project activities based on the matrix of activities and TOR activity TCE.
- Budget planning begins on September 14th, 2012 to February 20th, 2013.
- Schedule of events ranging from August 28th ,2012-Feb. 20th, 2013 as the matrix below.

Table 1. Schedule of TCE Programme

Planning for Third Country Expert from Indonesia (2012- 2013),
Mr. SUISMONO (Agricultural Postharvest Technology Development),
(August 20Th, 2012 – Febbruary 20Th, 2013)

NO	ACTIVITY	Augt	Sep	Sop	Nov	Dec	Jan	Feb.

	Preparation all activities base on TOR							
	Coordination with project office in Antananarivo							
	Coordination with CFAMA, DRDR, FOFIFA Antsirabe							
	Activty schedule, Budget request making							
2	**Idetification of potential locations (Survey on centre of rice production):**							
	- Investigation present situsiations of post-harvest of rice in cedntral hihland of Madagascar							
	- Reduce postharvest-losses and increase grain quality of rice with systematic approach combining the appropriate methods of cutting, thresing, drying, storage and milling							
3	**Paddy losses for postharvest handling :**							
	- Arrange of paddy losses measurement guide (SOP)							
	- Training and demontration methods of Paddy losses measurement							
	- Trial of SOP (Trial in the field)							
4	**Rice quality increasing :**							
	- Training and demonstration of rice quality analysis							
5.	**Field test and data collection of developed machines :**							
	Manual thresher performance test of machines / tools developed by provious TCE.							
	Increase of milled rice recovery (rendement) for RMU :							
	- Design animproving the prototipe equipment of the manual wood paddy separator							
	- Trial of separator prototipe to improve of paddy processing configuration in Rice Milling Unit							
	- Training of increase recovery for milled rice							
	- To make the prototipe equipment of the manual metal paddy separator in local manufacture							
	- To make and trial of Burner of Rice Husk Charcial and bricket pressing machine							
6.	**Report making :**							
	- Monthly report of activities							
	- Monthly report of accounting							
	- Final report of activities							

Antsirabe, August 30th, 2012

JICA Third Country Expert assigned to CFAMA,
Antsirabe, Madagascar

2.2. Evaluating present situsiations of post-harvest of rice in central hihland of Madagascar

- Survey field in highland (five region such as Vakinankaratra, Bongolava, Itasy, Alaotra-Mangoro and Analamanga regions) in Madagascar against respondent farmers, rice mill, rice traders, local manufacturing and goverment on postharvest handling of equipment used by the interview.
- Measurement of post-harvest losses of rice from each stage of harvesting, transporting, threshing, drying, milling, and storage to find rice post-harvest loss in highland Madagascar.
- Sampling and rice to determine the quality of grain and rice on each respondent and each region.
- Package postharvest technologies to reduce yield loss and improve the quality of rice.

2.3. Evaluating existing prototype of milling machinery

- Test equipment of capacity, input, output per hour.
- Feasibility and economical tool paddy separator and charcola rice husk burner.

2.4. Input of the project

Input Japanese side

1. Expert

1.1. Long term expert

- Chief advisor/ Agriculture Development, Project Coordinator, Desiminasi, Rice production, Farm management.

1.2. Short term expert

- Agriculture machinery, Agronomic technic (seed, fertilizer), Postharvest, Agriculture Economic/ Marketing.

1.3. Third Country Expert (ex. Agricultural Postharvest Technology)

2. Training

- Trainning by Japan and Third Country Expert.

3. Equipment delivery

- Vehicle, office equipment, ETC
- Other necessery input, expenses.

Input Madagascar side

1. Human resources, Counterpart and administrative personal

2. Building, office spaces and necessary facilities for the project activity

3. Local cost (operational cost for the project implementation)

III. RESULT

3.1. Evaluating present situsiations of post-harvest of rice in the Central Highland of Madagascar

3.1.1. Rice Postharvest Technology in the Central Highland of Madagascar

Rice postharvest handling is critical becouse determine value added (provit) farmers and the production and quality of rice nation wide, so whether or not the Goverment to import rice. Postharvest support the increase in production, especially in the aspect of weight losses during postharvest handling and milling recovery results in the milling process. Postharvest handling starting from the determination of the time of harvest, harvesting (cutting, gathering), transporting (collecting), threshing, drying, milling, and storage. Factors affecting shrinkage, quality and yield of rice during postharvest handling among other varieties, agro-ecosystems, cultivation techniques, post-harvest handling, processing (processing), equipment, human resources and socio-cultural skills. In this project a survey was conducted on postharvest of rice in the Central highland of Madagascar in the 5 regions which are Vakinankaratra, Bongolava, Alaotra-Mangoro, Itasy and Analamanga regions.

Generally of rice postharvest handling starts from harvesting, transporting (collecting), threshing, drying, milling and storing in Upland rice land in Madagascar following :

Phase of Harvesting

Rice harvest in highland Madagascar, there are 2 times of harvest season. First harvest in November-March with small harvest area and second harvest in May-November with a big area harvested. Harvesting system by paying labor cost for harvesters with 2500 to 4000Ar per person per day. Sometimes harvested by family labor for harvesting area is narrow (less than 1 are or 100m^2). Such systems can reduce yield loss (losses) on harvesting. The owner has the authority to regulate rice harvesters about when, where and how to harvest, including harvest facilities such as the use of the owner of paddy thresher base and tools used to threshing. Such systems can decrease losses on harvesting for not fight to get the pieces (owned by the owner of the fields). Harvester labor needed 50-80 people per hectare (average 60 people/ha) depending on the area of land and the availability of harvesters. To suppress the losses of rice required manpower needs 20 people harvester harvester / ha / day. Land in highland Madagascar mostly hilly topography (Table 2).

Harvesting is done in the morning around 7:00 – 10:00 am because the moisture is gone and the air is not too hot (Table 2). How to determine the rice is ready for harvest, if the grain has reached yellow color 100% (maturity physiology). Some farmers harvest young paddy plant because

of urgency need for their own consumption, although the result of rice yield is decreased and low quality (a lot of broken rice). Farmers harvest is mainly based on the level of maturity, regardless of weather conditions or land, whether it will rain or harvested land remains juicy. Should be harvested in the sunny weather and soil conditions are not a lot of water. They have had rain at harvest and delays, but prefer the level of maturity. They know if the rain causes grain rice yellow rice, they do not know that is a component of the grain yellow rice quality requirements. Yellow grain rice is considered ripe. Yellow grains occurs when rice was delayed 3 days did not immediately processed. Grain is a yellow pigment produced by the fungus and cause dangerous liver disease.

Farmers harvest in environmental (good) conditions : dry paddy fields, physiological maturity and sunny weather. Sometimes the farmers harvest paddy still with water conditions because of the difficulty of getting water so that water is retained (not discarded) for continuing planting. However, the results of cutting and threshing are done in a dry place.

Farmers harvest paddy by hand (cutting paddy manually by cycle local. Farmers cut paddy by way of cutting down the tuft of paddy at 5-10 cm above soil. Cut down as long panicles as possible for handling paddy when threshing manually and cut 3-6 tufts in one time (Table 3).

Tabel 2. Harvesting system

Regions	Harvesting times	Labour (people/ha)	Yields wages (Ar/day)
Vakinankaratra	At 7.00	25-75	3000
Bongolava	At 10.00	51-80	2500
Alaotra	At 6.00-7.00	13-44	4000
Itasy	At 7.00-8.00	62	3000
Analamanga	At 5.00-7.00	49-100	4000

Table 3 shows that, in general, farmers highland Madagascar rice manually cut with a sickle used locally made, but most use a serrated sickle. How to cut the rice by cutting down on the ground between 7-15. Once cut as many as 3-6 clump plants. The ability of farmers harvesting rice 5-7 hour/ha/60 people. Rice crop yield irregularly placed pieces that hinder harvesting. Once the rice farmers cut cleaning dirt at the base of the rice stem and tied with a rope for easy threshing time. This way cause losses of rice due to wobble and add jobs.

Table 3. Method of the farmer harvesting

Region	Method of farmer harvesting					Wages *(Ar/hr)*
	Cut up / bottom	Once cut down how	sickle type (normal /	Times harvest	Labour *(people/*	

		many clumps (clumps)	Old jagged)	(hours / ha)	*ha)*	
Vakinanka-ratra	Bottom (10 cm above ground)	1-4	Local sicle	5,5	25-75	2000-3000
Bongolava	Bottom (10 cm above ground	3-4	Local sicle	7,25	51-80	2500
Alaotra-Mangoro	Bottom (7-10 cm above ground)	3-6	Local serrated sickle	-	13-44	4000
Itasy	Bottom (10-15 cm above ground	3-6	Local sicle	-	62	3000
Analamanga	Bottom (8-15 cm above ground)	3-6	Local sicle	-	49-100	4000

Phase of Transporting (Collection)

Table 4 shows that farmers threshing rice in the fields or at home each region is different depending on the distance to the home. For the region as Bongolava topography hilly and lowland Itasy farmers away from home, so threshing rice in the fields. While the region are rice fields close to home as Vakinankaratra, Alaotra and rice Analamanga cutting results and threshing and transported to home by utilizing rice straw for animal feed. How to transport the rice manually when close to home and when away by Sarety (cart) or boat. Paddy losses can cause transportation. When thresing done in the field mean it will not happen transportasi loses. Distance collecting rice from the fields to the collecting (at home) between 5-25 km. Rice shelter, if accommodated in a threshing the field but when at home generally outsite house.

Table 4. Way of collecting or transporting of paddy plant

Region	Place of collection	Place of collection in house	Distance of transporttion (m)	Conveyance
Vakinankaratra	In house	outsite	300-5000	Manual-sarity (cart)
Bongolava	In field	-	5-25	Manual
Alaotra-Mangoro	In house	outsite	200-500	Manual
Itasy	In field	-	200	Manual
Analamanga	In house	outsite	100-200	Boat and sarity (cart)

Table 5 shows that the rice before dirontok farmers to defer the grounds for easy threshing, harvested in large quantities and the yellow grain rice is considered ripe. Delays are usually done at

home for 1-3 days with farmers stacked barefoot (directly on the ground). Gunduka 1-1.5 m high. Delay before threshing rice farmers mostly done in Vakinankaratra, Alaotra and Analamanga.

Table 5. Delays threshing

Regional	Place delays	Old (days)	Height mound (cm)	Given the base /not	Reason postponed
Vakinankaratra	In house	1-3	1-1,5	In the soil	-Many paddy,farmer habit -Near house
Bongolava	In field	No	no	No	Threshing in the field
Alaotra-Mangoro	In hopuse	2-3	-	In the soil	-Easy threshed -Yellow grain similar mature
Itasy	In field	no	no	no	Threshing in the field
Analamanga	In house	1	-	In the soil	

Phase of Threshing

Threshing mostly rice farmers still are maual with simple equipment is the system of dings on rock, drum or timber with plastic sheeting ata bare threshing, as in Vakinankaratra, Alaotra, and Itays regions. Base area thresher already meet standards of size more 8m x 8m (base area thresher at the farm level varies the 8m x 8m; 10mx10m) (Table 6). A small percentage begin using pedal thresher pedestal size 8mx8m or 10mx10m, as in Bongolava, Vakinankaratra and Analamanga. Working capacity of pedal threshers 150-250 kg grain / hour. The ability of farmers threshing using stone of 100 - 180 kg / hour, 2-3 people 2-6 times the power thresher and dings. Dirt straw that broke threshed back with a wooden bat.

Table 6 Method of the farmer threshing

Region	Method of the farmer threshing	Capasity (kg/hour)	Labour *(people)*	Base area *(mxm)*	Number of dings *(times)*
Vakinankaratra	Stone	108	2-3	10x10	2-6
	Pedal thresher	150-250	2-3	10x10 or 15x15	-
Bongolava	Stone	146-180	2-3	8x8	6-7
	Pedal thresher	1000	2	10x10	-
Alaotra-Mangoro	Stone	225	2	5x6 or 5x10	6-9
Itasy	Drum	187	2-3	10x10 or 15x15	5-10
Analamanga	Drum/ stone	228	2-3	8x8	6-7

Phase of Sun drying

Farmers usually dry the grain still using sun drying in plastic sheeting, as in Vakinankaratra, Bongolava, Alaotra and Itasy, but most are still drying grain on the ground, as in Analamanga. Floor of drying is used for threshing and breadth of the same base. Thickness of grain drying is generally 5 cm (between 2-10 cm), but the field varies between 2-10 cm. During drying performed reversal, every 15 minutes - 2 hours with one person workforce (Table 7).

Table 7 Method of the farmer sun drying

Region	Treatment (floor)	Size of floor *(mxm)*	Labour *(people)*	Thick drying (cm)	reversal (times)
Vakinankaratra	Terpal Floor	10x10	1	10	6-14 times, each 1-2 hour
Bongolava	Terpal Floor	8x8 or 10x10	1	2-5	3-12 times, each 1-2,5 hour
Alaotra-Mangoro	Terpal Floor	5x6 or 5x10	1	4-5	each 15-30 minutes
Itasy	Terpal Floor	10x10 or 15x15	1	2-8	Each 1-2 hour
Analamanga	Soil	8x8	1	2	Each10-30 minutes

Phase of Milling

Raw material of Paddy grain from farmers about the different varieties of rice mills, both varieties of long grain and short grain (Table 8). In highland Madagascar generally , Management System of Rice milling services milled the grain raw materials owned by farmers and rice traders, both on Rice Milling Unit (RMU) medium scale and small scale. The raw materials are milled grain from farmers for their own consumption so that the quality of rice produced is not a quality requirement, so that single pass rice mill and Engleberg is not a problem. While derived from rice traders to be sold to pay attention to the quality of the rice market by RMU Single pass and Engleberg will produce low quality rice, so many low-quality rice at the market.

Quality requirements to be milled grain generally qualify compoment is good quality views of the moisture content (max. 14%) and the empty grain and dirt (max 3%). Farmers pay attention to the level of dryness and cleanliness of grain during the process of sun drying. Methods of the farmer to know the dry paddy grain are to touch and shake the grains by hand .

Table 8. Conditions of milled materials

Region	Raw materials			
	Variety	Prices of dry paddy grain *(Ar/kg*)	Origin of material	Moisture content of materials *(%)*
Vakinankaratra	Long dan shot grain	750-800,-	Farmer (10-12km)	11,93
Bongolava	Long dan shot grain	800,-	Farmer (2 km)	12,37
Alaotra-Mangoro	Long dan shot grain	900-1200	Farmer (5km)	10,85
Itasy	Long dan shot grain	1150-1200	Farmer (10-30km)	9,41
Analamanga	Short grain	1150	Farmer (5-7km)	12,49

Rice milling system

Rice milling system in highland Madagascar such as 2 system which consists of a single pass and a double pass system. Single pass system there are two types: engleberg and abrasive types.

1. Rice Milling Single Pass

Single-pass rice mill rice mill type engleberg is composed of only one device serves as breaking the skin (husker) and as the polish (polisher) of paddy grain directly to produce milled rice. Single pass rice mill rice mill type of abrasive is composed of two shell-breaking tool (husker) and penyosoh (polisher) in one of the machine immediately so the rice grain.

The kind of rice polisher such as 2 types : polisher of abrasive type and friction types. Polisher of abrasive type is equipped stone of aleurone / brand polish and produce white rice but bran still attached. While the type of friction is equipped metal device polish will be friction between the grains and produce transparan rice , clear and no rice bran. In the milling processod single pass system will produce a lot of rice bran that is not white, a lot of broken rice and groats will reduce the yield of rice. This Rice milling is growing due to the small area of paddy fields and farmers themselves and only for consumption. As a Milling services (farmers' rice yield) that RMU is not harmed by the low quality and farmers accept it because there is no option other RMU. Single-pass rice mill lot to do in highland Madagascar, especially in the region Vakinankaratra, Bongolava and Alaotra (Table 9). Engleberg type rice milling capacity of 500 kg / h, the average rice production of 600-2500 kg / day with a 15 HP electrical propulsion and generating rendement 65-75%. While the single-pass rice mill type of abrasive capacity of 500 kg / h, the average production of 500-2000 kg / day with a 25 HP diesel propulsion engine fuel gas oil (3-5 liter / ton of grain) and the yield of milled rice produced 66-72 %. Wages 30-40Ar bran milled rice mill owned**.**

Table 9. Rice Milling of Single Pass processing

Regions	Type	Production (t/hr)	Merk	Year of buy	Activator Fuel Power					Rend. Milled rice (%)	Wages milling (Ar/ kg)
					Diesel (HP)	Fuel.	Need of fuel (L/t)	Price (Ar/liter)	Electric (KWH/ Watt/HP		
Vakinanka-ratra	Single pass abrasive	0,5-2	RRC	2006	45	Gas oil	3-4	2990	-	70-72	40
	Engleberg	2,5	RRC	1993	-	-	-	-	15 HP	65-75	40
Bongolava	Single pass friction	2	RRC	2007	25	Gas oil	5	2750	-	66-70	30
Alaotra	Engleberg	0,6	-	2003	-	-	-	-	15 Hp	-	30-40

2. Rice Milling Double Pass

Double-pass rice mill rice is mill consists of skin-breaking tools and equipment penyosoh with different machines (two units of the machine). Usually double pass rice mill for the production of medium and large-scale rice. Rice Milling double pass medium scale rice is mostly done in Itasy and Analamangga region to serve farmers and rice traders. Polishing commonly used type of friction that produces rice, clear / trasparans. Machines that are used in double pass rice mill in Madagascar already qualified, but the configuration / setup machines in the milling process is less precise. Rice milling system configurations that exist in Madagascar generally Husker-Husker-Pilisher (HHP) and some milling with CHHP configuration. This configuration still produce a low yield of rice due to the composition of HH will make the skin broke again to brown rice cracked and broken rice / groats when polished up(Table 11). Milling rice in medium-scale double pass highlan Madagascar equipped with a continuous conveyor system, capacity 1000-1500kg / h with dynamo electric propulsion 15-30 HP (18.5 Kwh). Milling system with the configuration done in Itasy CHHSP (Table 11), Analamanga and Vakinankaratra. While the double-pass rice mill scale, is not equipped with conveyors, 500kg/hour capacity 35 HP engine-driven fuel gas oil (20 liters / 4 ton of rice milled(Table 10).

Tabel 10. Brown rice husked processing

Regions	Capasity (kg/hour)	Mark	Year of buy	Activator Fuel Power			
				Diesel (HP)	Fuel.	Need fuel (liter/ton)	Electical (HP)
Vakinankaratra	1500	RRC	2000	-	-	-	15-30
Alaotra	500	LNJ 115-1	2010	35	Gas oil	5	-
Itasy	1000	RRC	2000	-	-	-	35
Analamanga	1500	RRC	2003	-	-	-	30

Tabel 11. Rice polished processing

Regions	Cap. (kg/ hour)	Mark	Year of buy	Activator Fuel Power				Rende-men (%)	Wages rollers (Ar/kg)	Configuration of milling system
				Diesel (HP)	Fuel.	Need fuel (liter/ton)	Electric (Kwh/ Watt/HP)			
Vakinankaratra	1500	RRC	2000	-	-	-	15-30HP	70	40	C-H-H-S-P
Alaotra	500	RRC	2010	35	Gas oil	5	-	70	30-40	H-H-P
Itasy	1000	RRC	2000	-	-	-	15HP	60-70	20	H-H-S-P
Analamanga	1500	N-130A	2001	-	-	-	18,5 Kwh	70	60	H-H-S-P

Note : C= Paddy Cleaner, H=Husker, S=Separator, P=Polisher

Phase of Storage

Most farmers store dry paddy with packaging system in the storage area inside the farmer house. Generally, the upper house to stay, while the bottom for storage of paddy. Dry paddy grain partly sold and partly consumed itself with the comparison of grain for sale: grain stored = 50:50; 30:70, or 70:30. Storage system with plastic sheeting packing capacity 3-12 tons with an old save 5-12 months, without floor and without pallet. Warehouse pests (Ryzoperta indica, Tribolium castanium (pest warehouse) does not occur (Table 12).

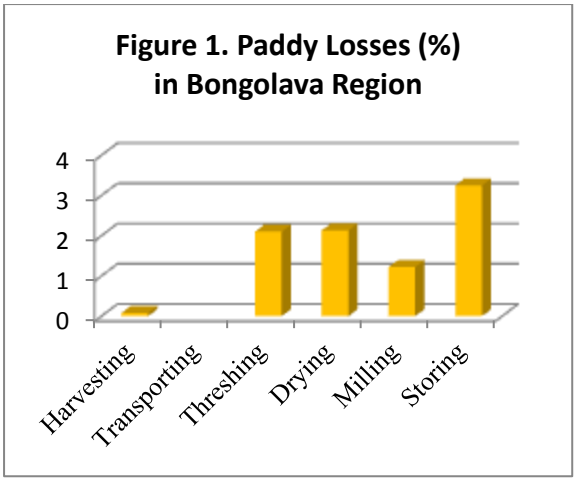
Tabel 12. Storage system of paddy or rice with packaging of plastic sack *(polypropilen)*

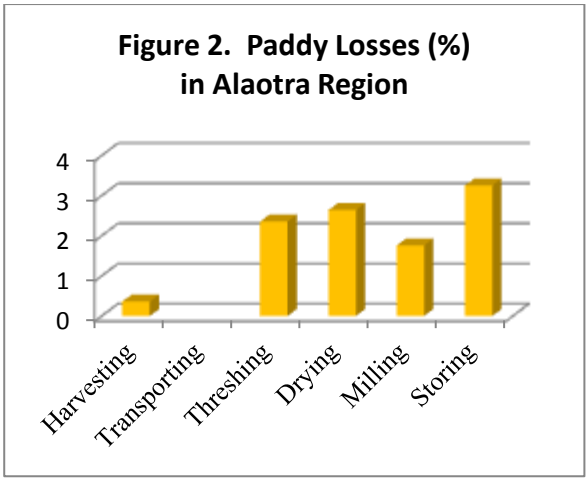
Region	Storage system	Compari-son of pady grain sold: saved	Type of packaging	Cap. (ton)	Stored times (mooth)	Moisture content (%)	Based of pallet	Pest store	Stored site
Vakinanka ratra	Packaging system	0:100	Plastic sack	12	5-10	11,9	Floor of rice husk	No	In house
Bongolava	Bulk system	50:50,	Bulk	3-5	6-12	12,37	-	-	Out house
	Packaging system	67:33	Plastic sack	5	5-6	10-13%	No	No	In house
Alaotra	Packaging system	30:70, 0:100	Plastic sack	3-5	8-12	10,85	No	No	In house
Itasy	Packaging system	0:100	Plastic sack	3	5-8	9,41	No	No	In house
Analaman ga	Packaging system	50:50, 70:30. 85;15	Plastic sack	4	5-12	12,49	No	No	In house

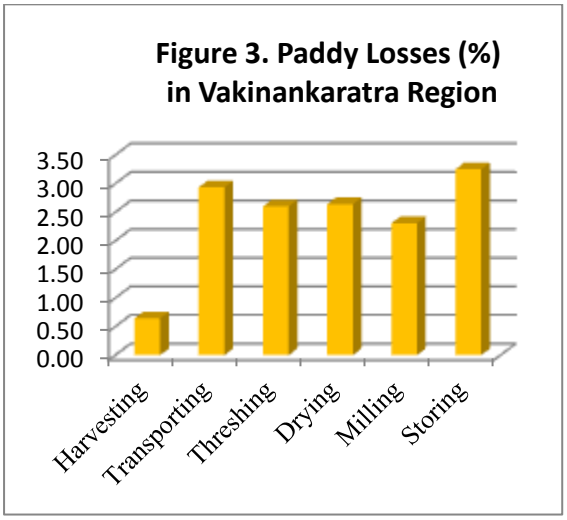
3.1.2. Evaluation of Paddy Losses in highland in Madagascar

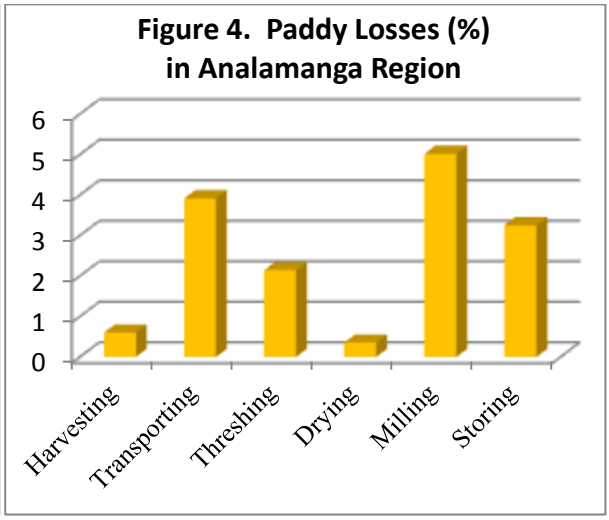
During postharvest handling occur paddy losses (from harvesting, Transportation /gathering, threshing, drying, milling and storage) in highland Madagascar was high (14.19%). Each phase of post-harvest handling, farmers do a lot of ways / methods of different post-harvest handling of rice, such as the phse of collecting stover before threshing at home with sariti (cart) transported manually or even a boat or car. Similarly, the phase of threshing, farmers to threshsing with manual using stone, drum, or wood either directly on the ground. Phase of sun drying, with base plastic sheeting or mat or directly on the ground or paved road. Phase of milling, many Rice Milling Unit (RMU) perform different rice mills, among other management and processing system for rice milling.

Paddy losses in each region is different because of different postharvest handling at every phase of the process of post-harvest. Paddy losses at this phase of threshing, drying and milling for all the region an average of 2%, while the lowest to the highest phase of harvesting and transportation and storage phases (3%) (Figure 5). Paddy losses in Alaotra, Bongolava lower than Vakinankaratra region and Analamanga because harvesting in the field, so no losses transportation (Figure 1-4).









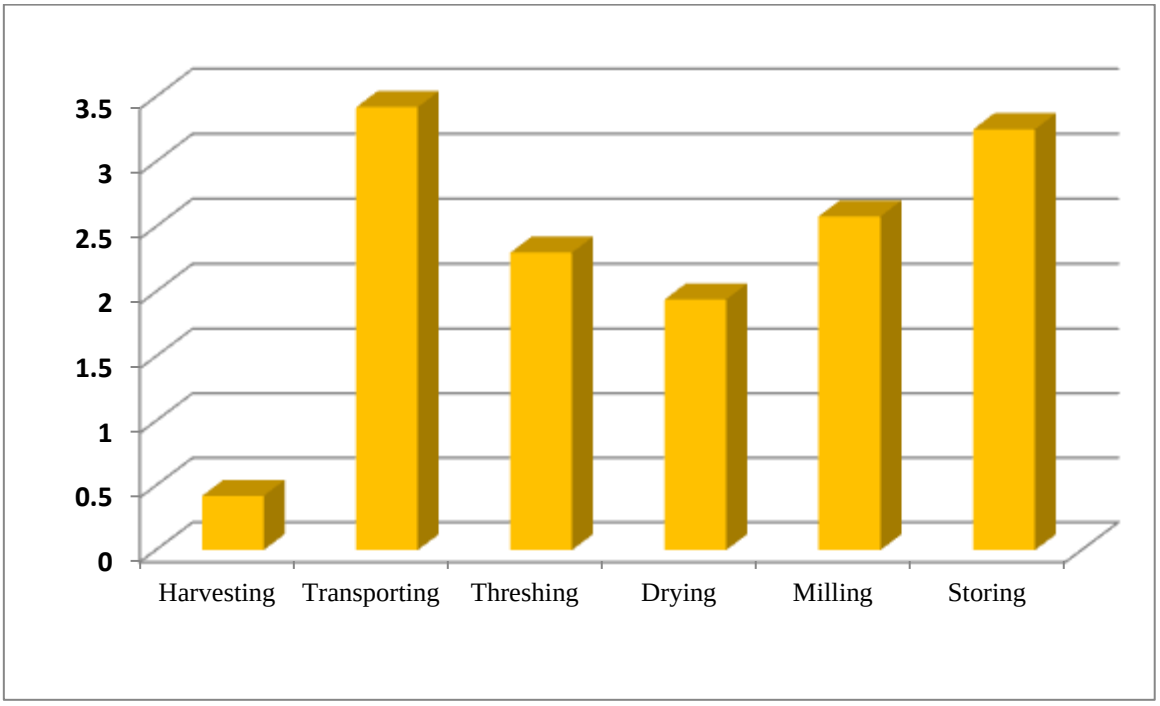


Figure 5. Paddy Losses (%) In Highland In Madagascar

Table 13. Paddy losses at each phase of postharvest and some t treatments in highland Madagascar (2013)

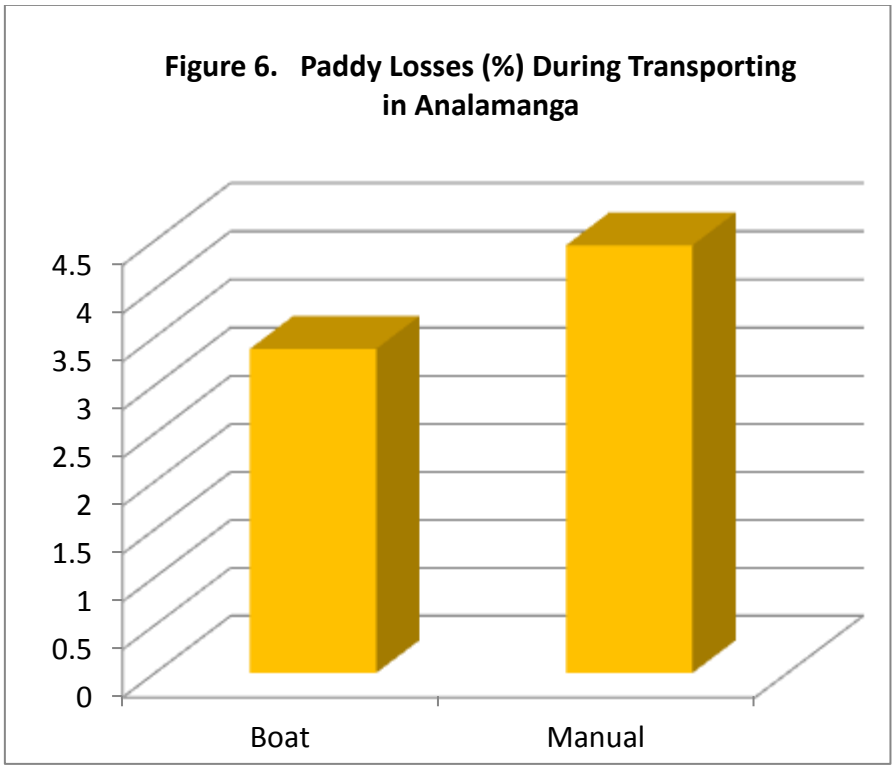
NO	COMPONENTS	LOSSES (%)				
		n	Min. (%)	Max. (%)	Average	STD
I.	**PHASE OF HARVESTING**	13	0,03	1,34	0,61	0,446
	Manual				0,61	
II.	**PHASEOF STRAW TRANSPORTATION**	7	1,13	5,86	3,42	1,594
	Manual				3,42	
III.	**PHASE OF THRESHING**	15	0,85	5,75	2,72	1,364
	Manual- stone -soil				2,83	
	Manual – drum - soil				2,86	
	Manual –stone-terpal				3,09	
	Manual-wood-terpal				5,58	
	Pedal thresher				1,27	
IV	**PHASE OF DRYING**	8	0,32	2,96	2,08	1,046
	Aspal floor (in the road)				2,02	
	Terpal floor				2,58	
	Mat floor				1,80	
	Soil floor				1,60	
	Cement floor				2,89	
V	**PHASE OF MILLING**	**14**	**0,24**	**4,59**	2,12	1,895
	One pass				2,14	
	Double pass (Itasy)				2,07	
VI	**PHASE OF STORING**	**3**	**2,88**	**3,77**	3,25	0,465
	Plastic sack				3,25	
	TOTALS				14,19	

Losses of Harvesting

Lowest losses at harvest for all the region on average by 0.67% (Table 13). This is because (a) the harvest system the labor wage paid per day, so do not fight and reduce sway despite using a sickle (manual). Sickle used some farmers are serrated sickle (crescent particular crop) , (b) the amount of labor is limited by the owner from 40-55 people for an area of 1 ha and harvest small area so no paddy losses. Paddy losses on phase harvest coused factor cutting, putting and collecting of tuft, and (c) the use of new varieties is a widely used resistance variety such as 2025 for Bongolava farmers.

Losses of Transpoting

Paddy losses is highest at this phase stover collection for threshing transported to home as much done in the Vakinankaratra, Mangoro and Analamang region. Farmers to execute the threshing in home because (a) the wetland near the village, (b) straw for animal feed and (c) in Analamanga when rice straw will be left in stagnant water because the area is low. In Mandoto transporting stover manually or with Sariti (cart), being in Analamanga from the fields to the edge of the village by boat (booth) and then transported to home manually when near the house or the car or Sariti when far the house. This will happen losses the collection and use of local varieties of rice will increase losses. If the threshing in fields because the location far from the farmer's house, as in Bongolava region, so there is not collection losses.



Losses of Threshing

Paddy losses during threshing were highest using manual of the tools wood (5.58%) than the drum (2.88%) and stone (2.4 to 3.0%) (Table 13). Using of wood and drum due have the ability to the grain that tossed far due to dings on the threshing than stone tools. Mostly, the farmers threshing of paddy grain with manually by using the tools stone (sometimes a special stone that is used for rice threshing tool is also used to pound the paddy). When

threshing in fields equipped with extensive tool plastic terpal sheeting base average of 10 mx 10 m, and when threshed home directly on the ground. The place used to the threshing at home is special hardened ground already hard as it is made from a mixture of soil and cow dung. Threshing with the wood tools do by farmers in Alaotra-Mangoro, whereas with a drum in Vakinankaratra and Analamanga. Some farmers have use pedal thresher are used by farmers in Bongolava and Analamanga lowest losses and produce an average of 1.2%.

Figure 7. Paddy Losses (%) During Threshing In Bongolava

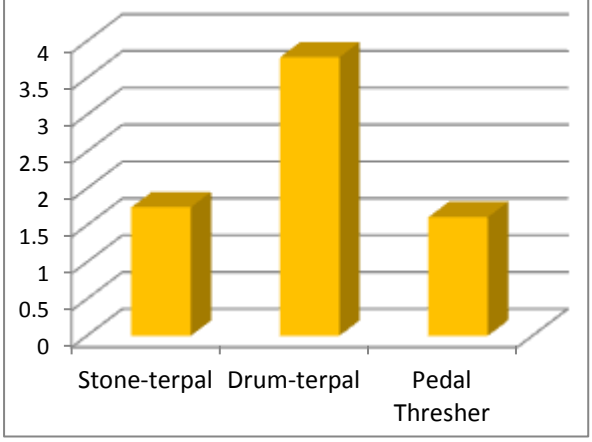


Figure 8. Paddy Losses (%) During Threshing In Alaotra-Mangoro

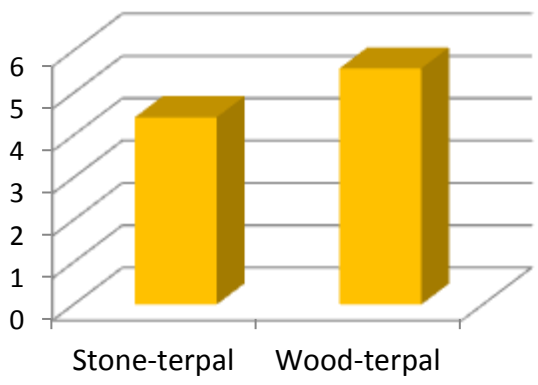


Figure 9. Paddy Losses (%) During Threshing In Vakinankaratra Region

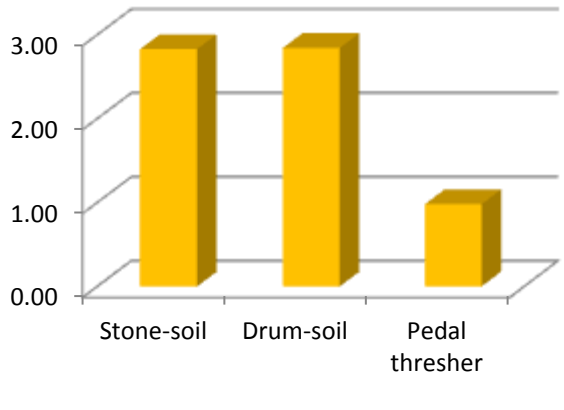
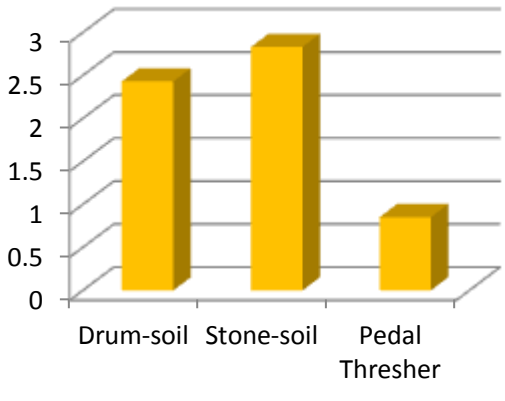


Figure 10. Paddy Losses (%) During Threshing In Analamanga

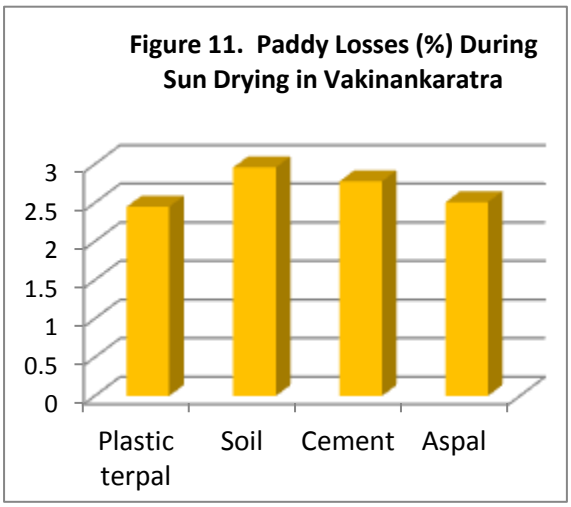


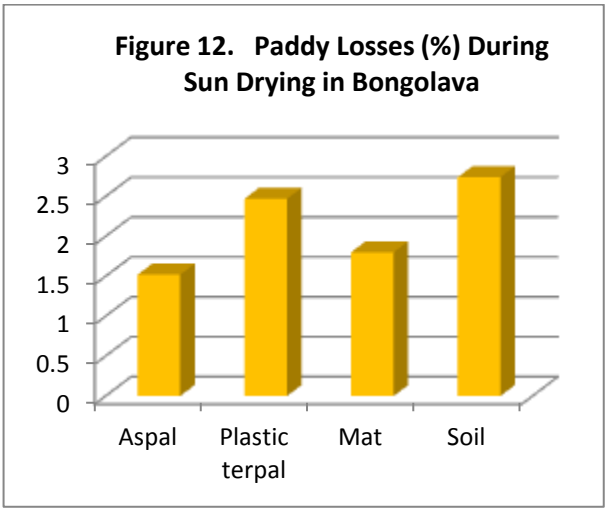
Losses of Sun Drying

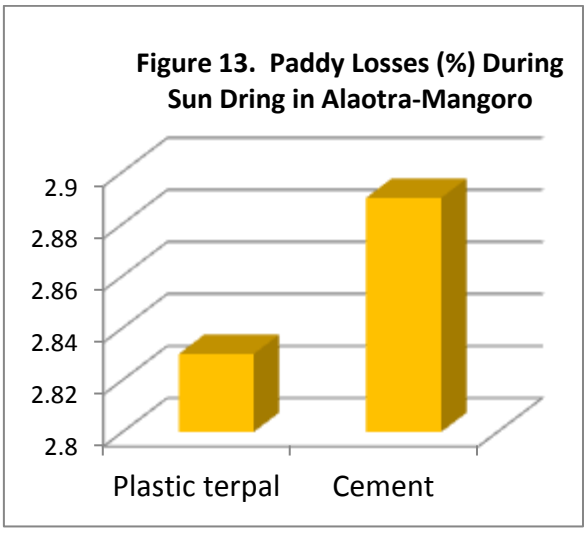
Paddy losses during sun drying average 2.03% (between 0.37 to 2.89%)(Table 13) as long as the survey was not encountered in the field use artificial drying (drying machine), more the farmers and rice milling with Sun drying. Losses of sun drying varies depending on

sun drying method and base of sun drying condition of local farmers. The basis of plastic terpal using sun drying for farmers is to use an area of a base threshing 10m x 10m size on average. But for small farmers, they use simple methods such as mat, sacks above ground and above the asphalt sidewalk with a small size floor and result less qualified for the base drying.

Paddy losses of sun drying on the ground and asphalt in the road mat are lower because the amount of paddy grain that is dried is little. While using tarpaulin (terpal) and cement floor, and generaly, material of paddy grain initial conditions from the field are still dirty. During drying the reversing is every 2 hours while cleaning the dirt the final weight of the dried grain is obtained. There are losses because animals eat paddy around or holes appear in the sacks of grain. The principle of drying losses is not due to reduced moisture content of grain due to drying losses but due to the weight before and after drying by dry weight (dry basis).







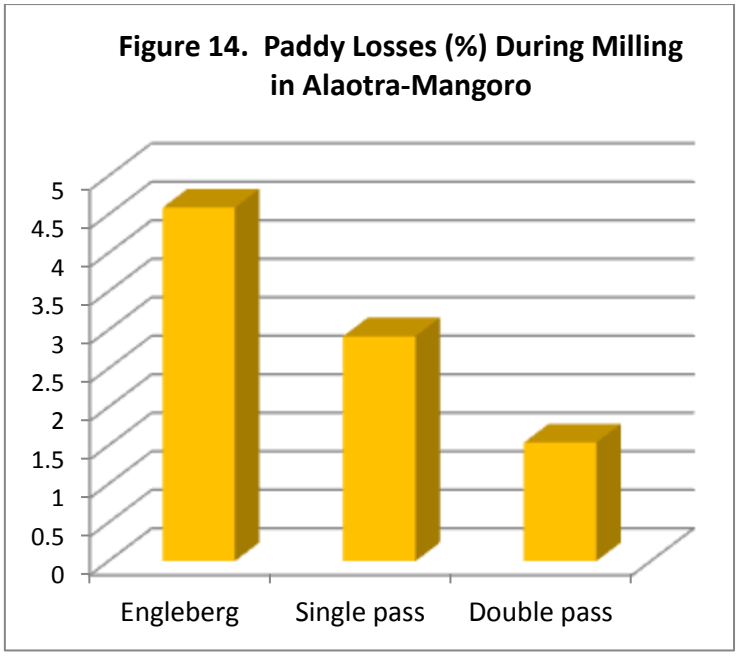
Losses of Milling

During the process of rice milling, configuration system can be affect to the paddy losses. Type of the engleberg milling system result paddy losses highest (4%) compared than one-pass system (2.5%) and double pass (1.3%) in rice mills in Alaotra-Mangoro regin (Table 13).

Rice mills in highland Madagascar consists Rice milling small scale of mostly), medium scale and big scale. Management of rice milling mostly Rice milling as public services (rental) and performed by Rice milling small an mediumscale, but rice milling big scale to mill the company's special paddy. The system of milling services, so that the desire of consumers (farmers) preferred the more priority the recovery (rendement) than the rice quality, so that the rice milling use simple process, so that over low quality despite the grinding type engleberg or one pass. Engleberg rice Milling type is a system in which a single unit of the machine is the only one tool which serves to break the husk and polish. So result many broken rice polished and consequently the appearance of milled rice is not white because a lot of bran still attached.

The rice milling of one pass type, it does not include paddy separator. In the one-pass system, brown rice grain yield husking process still more paddy grain so that when on the husking process again means brown rice processed 2 times as a result many are cracked and broken so when polished. But if after husking process to direct polished some paddy grains together with millied rice. While grinding type of double pass rice mill where the system consists of two units, namely 1 unit machine leather the husker machine apart with 1 unit the polisher machine. These systems are generally equipped with a bunch of paddy seperator engine and 2 units polisher machines.

The results show that the recommendation system should be double pass rice mill because with husker machine and a tool paddy seperator direct the result can polished and returned paddy grain to husker machine. The use of 2 tools for polishing do not press milled rice (gradual), with medium rotary speeds (1100 rpm)\ so that the rice is not broken, clean with high rendement.



Losses of Storing

Grain storage in the form of dry paddy grain most in the house of the plastic bag packaging and a little farmers do a special storage place outside the house bulk system. Storage of dry paddy grain to pack a plastic bag inside the house farmer Bongolava still produce high losses (3.25% (Table 13)). Because storage is not qualified (no aeration holes and fitted storage pallet) so that the effect of changes in the moisture content of the surrounding water is very real. In fact, the initial moisture content of grain storage will increase the low water content (moisture balance by relative humidity).

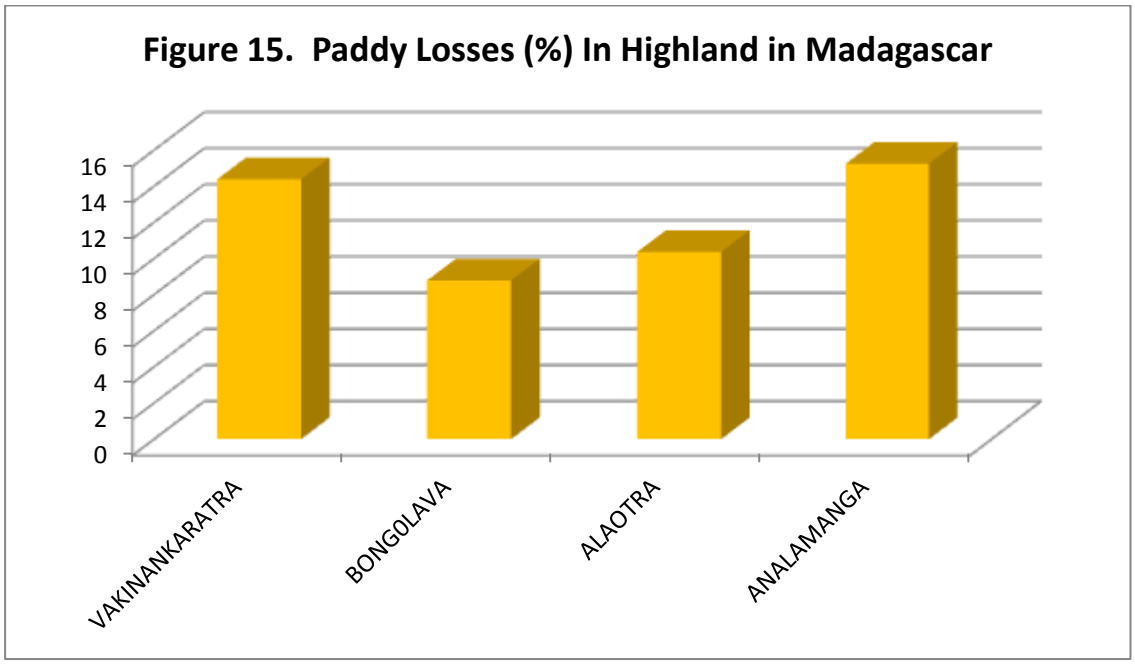


Table 14. Paddy losses each region in Central Highland Madagascar

Phase of Postharvest	Vakinankaratra	Bongolava	Alaotra	Analamanga
Harvesting	0,64	0,08	0,36	0,60
Transporting	2,94			3,91
Threshing	2,60	2,10	2,35	2,14
Drying	2,64	2,13	2,64	0,35
Milling	2,31	1,22	1,76	5,01
Storing	3,25	3,25	3,25	3,25
Tolals	14,38	8,78	10,36	15,25

Paddy losses during postharvest from the phase of harvest to storage in highland (5 regions) Madagascar is 14.19%. Paddy losses highest in Vakinankaratra and Analamangga regions respectively 15.25% and 14.38%) and paddy losses lowest in Bongolava terendal region of 8.78% (Table 14).

3.1.3. Evaluation of Rice Quality in highland in Madagascar

In evaluating the rice quality in highland Madagascar can be seen from the rice quality of produced by the rice mills and rice sold by rice traders in the market. Therefore conducted field survey on the respondents of rice miller and rice seller in five regions highland (Vakinankaratra, Bongolava, Alaotra-Mangoro, Itasy and Analamanga) in Madagascar. Respondents of Rice milling includes both small, medium and large, involve milling engleberg type, single pass and double pass. Respondents of rice traders include rice traders retail in the market, wholesalers and supermarkets. The rice varieties sampled was not dependent, either local varieties, new varieties, government stocks and imports.

1. Rice Quality in the Rice Milling Unit (RMU)

Based on the quality components intact rice shows that the milled rice in all rice producing region broken rice is more than 20% including quality grade IV in Indonesian rice quality standards (Table 15). This is because the small-scale milling Rice mostly using engleberg type milling machine and a single pass.

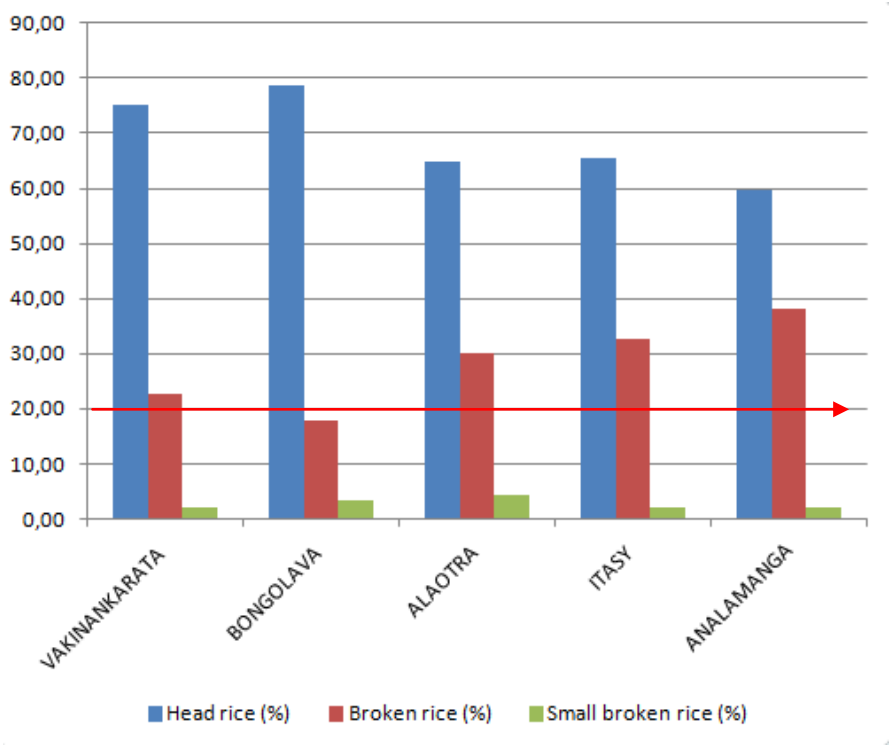


Figure 16. The percentage of head rice, broken rice and small broken rice in each Rice Milling Unit Region highland Madagascar

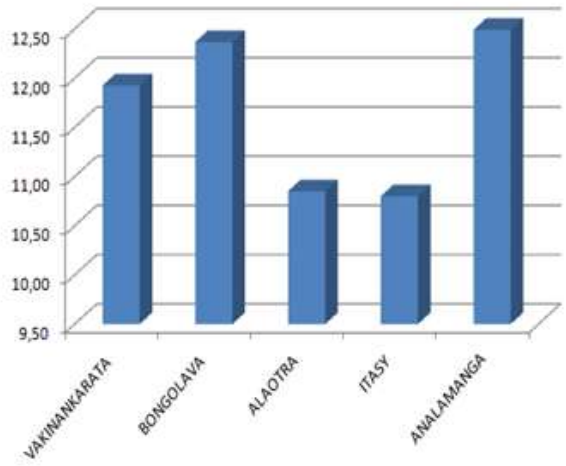


Figure 17. Moisture content for rice in Rice milling unit

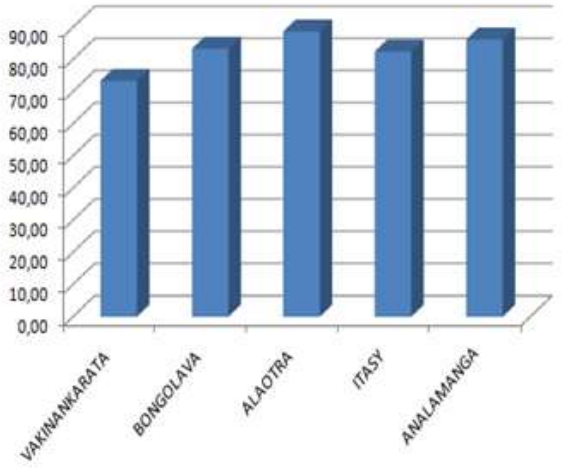


Figure 18. Milling degree for rice in Rice milling unit

Rice moistute content to meet the quality requirements of rice (less than 14%) due to the paddy grain of the farmer is dry on the drying process. However, the quality of the rice component milling degree does not fulfill the quality requirements of rice (milling degree less than 90%) due the milling syatem of single-pass abrasive and engleberg type to produce the milled rice is still many the

rice brand. For red rice varieties rice the milling degree does not matter because in maintaining red rice milling degree is not required up to 90% for the porridge on the breakfast food "Warsusu"(Tabel 15).

For rice quality components that include chalky, yellow, damage, and red grains and paddy grain has been qualified for less than 3% (Table 15). Rice sampling results containing the largest percentage of red grains means many redvarieties(Figure 19).

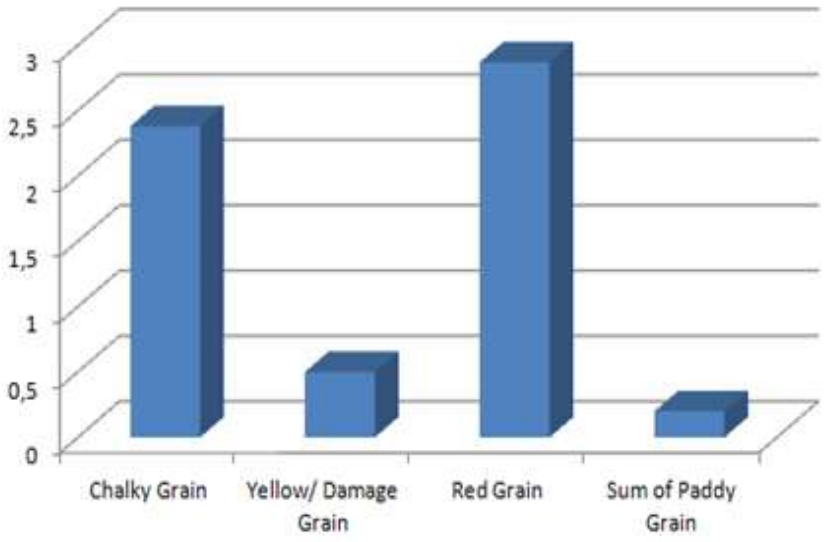


Figure 19 . Chalky, yellow, damage, red and paddy grain for rice quality in Rice Milling Unit in Highland Madagascar

. Rice Quality in the Seller

Rice quality of trader level in 5 regions (Vakinankaratra, Analamanga, Bongolava, Alaotra-Mangoro, and Itasy) have the percentage of broken rice also has more than 20% excluding grade IV in Indonesian rice quality standards. Rice moisture content in the rice traders meet quality requirements (less than 14%), but low levels of white rice (milling degree less than 90%)(Tabel 16).

Table 15. Rice quality of rice milling in each region of highland Madagascar

COMPONENT	REGION	N	AVERAGE	MIN	MAX	STD	Standard of Rice quality SNI Grade IV
Moisture content (%)	Vakinankaratra	12	11,93	9,4	13,7	1,54	Max.14%
	Bongolava	3	12,37	12,10	12,50	0,23	
	Alaotra	4	10,85	9,70	12,10	1,06	
	Itasy	6	9,41	1,06	11,40	0,43	
	Analamanga	4	12,49	11,76	13,30	0,69	
Head Rice (%)	Vakinankaratra	12	75,08	49,8	91,26	11,39	Min.73%
	Bongolava	3	78,54	71,77	85,48	6,86	
	Alaotra	4	64,97	58,02	78,06	9,15	
	Itasy	6	57,29	9,15	77,62	3,30	
	Analamanga	4	59,73	50,10	84,03	16,30	
Broken rice (%)	Vakinankaratra	12	22,79	8,73	40,31	9,28	Max.25%
	Bongolava	3	17,95	12,90	23,58	5,36	
	Alaotra	4	30,11	19,71	34,40	7,11	
	Itasy	6	29,05	7,11	37,30	1,38	
	Analamanga	4	38,21	12,97	48,68	16,97	
Small broken rice (%)	Vakinankaratra	12	2,16	0	9,8	2,74	Max.2%
	Bongolava	3	3,49	1,60	4,63	1,65	
	Alaotra	4	4,31	0,80	6,20	3,37	
	Itasy	6	2,30	0,99	5,07	1,82	
	Analamanga	4	2,05	1,21	2,99	0,75	
Milling degree (%)	Vakinankaratra	12	73,33	60	85	10,30	Min.95%
	Bongolava	3	83,33	80,00	85,00	2,89	
	Alaotra	4	88,75	85,00	95,00	4,79	
	Itasy	6	71,40	4,79	95,00	17,50	
	Analamanga	4	86,25	80,00	95,00	6,29	
Chalky Grain		12	2,38	0,19	4,61	1,48	Max.3%
Yellow/ Damage Grain		12	0,50	0	2,2	0,65	Max.3%
Red Grain		12	2,87	0	11,8	3,37	Max.3%
Sum Of Paddy Grain		12	0,20	0	0,8	0,33	Max.2%

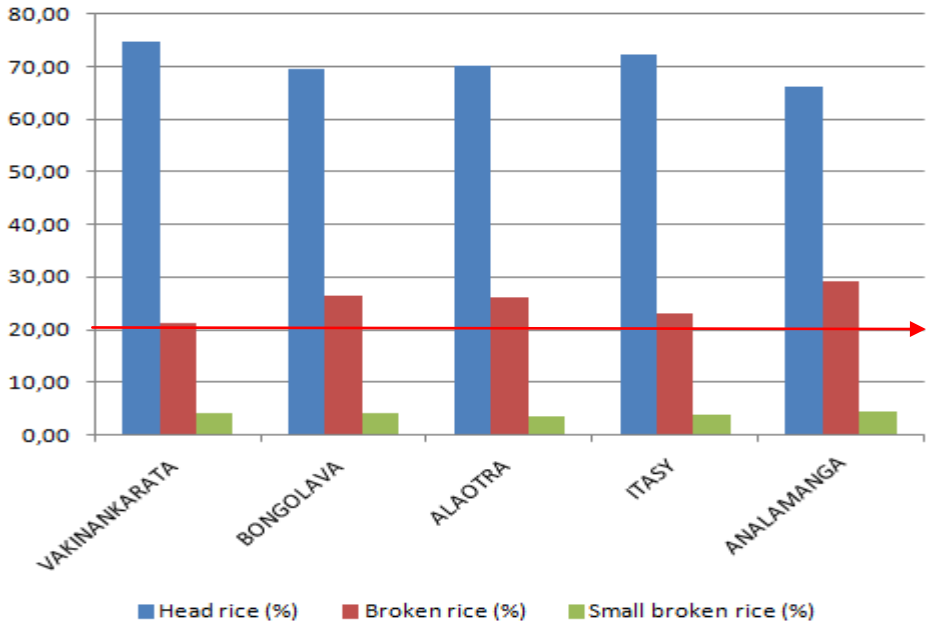


Figure 20. The percentage of head rice, broken rice and small broken rice in each Rice seller Region highland Madagascar

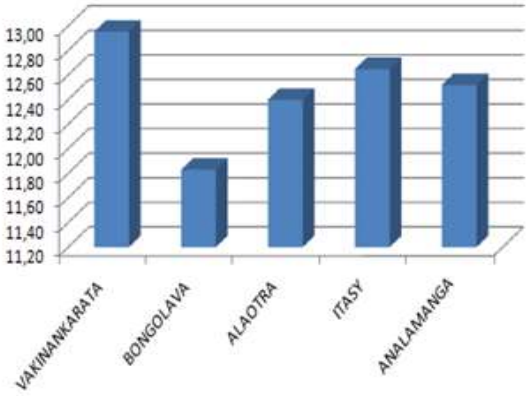


Figure 21. Moisture content for rice in Rice seller

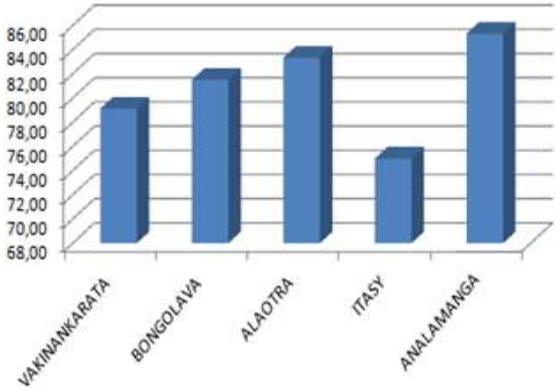


Figure 22. Milling degree for rice in Rice seller

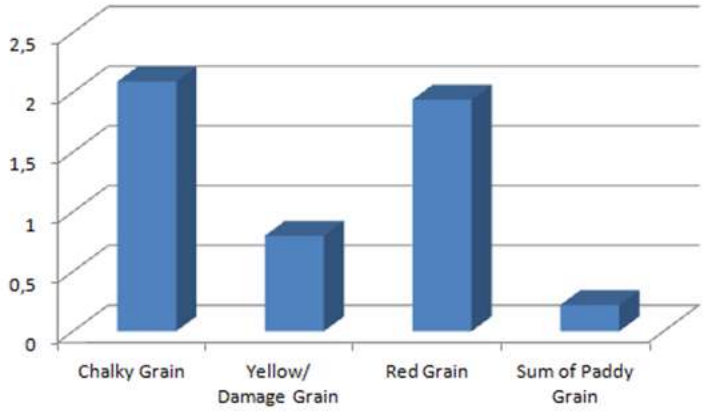


Figure 23 . Chalky, yellow, damage, red and paddy grains for rice quality in Rice Seller in Highland Madagascar

Table 16. Rice quality of rice seller in each region of highland Madagascar

COMPONENT	REGION	N	AVERAGE	MIN	MAX	STD	Standard of Rice quality SNI Grade IV
Moisture content (%)	Vakinankaratra	14	12,95	11,00	14,00	0,90	Max.14%
	Bongolava	10	11,83	10,20	13,00	0,97	
	Alaotra	6	12,40	10,90	13,80	0,92	
	Itasy	14	12,54	11,20	13,60	0,82	
	Analamanga	12	12,52	11,00	13,30	0,57	
Head Rice (%)	Vakinankaratra	14	74,75	50,00	94,41	12,25	Min.73%
	Bongolava	10	69,41	39,63	88,15	14,87	
	Alaotra	6	70,31	46,88	88,02	14,08	
	Itasy	14	72,35	54,19	86,80	11,15	
	Analamanga	12	66,06	42,82	84,03	11,01	
Broken rice (%)	Vakinankaratra	14	21,25	2,18	48,03	13,15	Max.25%
	Bongolava	10	26,53	10,84	51,50	13,86	
	Alaotra	6	26,23	11,57	47,88	12,50	
	Itasy	14	23,05	13,24	37,42	8,14	
	Analamanga	12	29,30	12,97	55,00	11,08	
Small broken rice (%)	Vakinankaratra	14	4,05	0,00	12,72	4,01	Max.2%
	Bongolava	10	4,05	1,00	8,85	2,82	
	Alaotra	6	3,45	0,39	5,84	2,04	
	Itasy	14	3,76	0,63	8,38	2,32	
	Analamanga	12	4,50	0,30	16,10	4,08	
Milling degree (%)	Vakinankaratra	14	79,12	50,00	95,00	10,93	Min.95%
	Bongolava	10	81,50	60,00	95,00	9,14	
	Alaotra	6	83,33	75,00	90,00	5,16	
	Itasy	14	76,43	60,00	90,00	9,29	
Chalky Grain		20	2,09	0,19	4,95	1,75	Max.3%
Yellow/ Damage Grain		20	0,80	0,00	3,54	0,79	Max.3%
Red Grain		20	1,94	0,00	11,80	4,08	Max.3%
Sum Of Paddy Grain		20	0,21	0,00	0,80	0,31	Max.2%

Table 17. Indonesian National Standard for Paddy grain No. 01-0224-1987

No	Quality Criteria	Unit	Grades		
			I	II	III
1	Moisture content	(%, max.)	14	14	14
2	Empty grain / dirt	(% max.)	1	2	3
3	Damaged/yellow grains	(% max.)	2	5	7
4	Chalkyness grains	(% max.)	1	5	10
5	Red grains	(%, max.)	1	2	4
6	Foreign material	(% max.)	-	0,5	1,0
7	Paddy of other variety	(% max.)	2	5	10

Table 18. Indonesian National Standard for Rice N0. 6128-2008

No	Quality Criteria	Unit	Grades				
			I	II	III	IV	V
1	Milling degree	(%, min.)	100	100	95	95	95
2	Moisture content	(%, max.)	14	14	14	14	15
3	Head rice	(% min.)	95	89	78	73	60
4	Broken rice	(%, max.)	5	10	20	25	35
5	Minute kernel	(%, max.)	0	1	2	2	5
6	Red grains	(%, max.)	0	1	2	3	3
7	Damaged/yellow grains	(% max.)	0	1	2	3	5
8	Chalkyness grains	(% max.)	0	1	2	3	5
9	Paddy grain	(% max.)	0	0,02	0,02	0,05	0,2
10	Foreign material	(% max.)	0	1	1	2	3

Table 19. Quality standards for milled rice in Philippines (National Food Authority)

Grade Specifications	**GRADE**			
	Premium	**Grade 1**	**Grade 2**	**Grade 3**
Head rice (min %)	95.00	80.00	65.00	50.00
Brokens (max %)	4.90	19.75	34.50	49.00
Brewers (max %)	0.10	0.25	0.50	1.00
Defectives:				
Damaged grains, max %	0	0,25	0,50	2,00
Discolored grains, max %	0.50	2,00	4,00	8,00
Chalky and immature grains, max %	2,00	5,00	10,00	15,00
Red grains, max %	0	0,25	0,50	2,00
Red streaked grains, max %	1,00	3,00	5,00	10,00
Red streaked grains, max %	0	0,10	0,2	0,50
Paddy (max no./kg)	1	8	10	15
Moisture content (max %)	14,00	14,00	14,00	14,00

3.1.4. Package of Post-harvest Technologies to reduce paddy losses

Based on the evaluation of paddy losses in the field can be recommended a package of post-harvest technologies to reduce paddy losses in Madagascar highlan. By the farmers postharvest technology by paddy losses 14.19% and paddy losse through technology package recommended by 8.53% so it can suppress paddy losses of 5.66% (Table 20).

Table 20. Postharvest technology to decrease for paddy losses highland Madagascar

No	Phase of postharvest	Postharvest Technology			
		Farmer technology		Recomendate of technology Package	
		Component	Losses (%)	Component	Losses (%)
1	Harvesting	Manual	0,61	Manual	0,61
2	Transporting	Manual	3,42		-
3	Threshing	Manual-stone/drum-soil	2,72	Pedal thresher-terpal	1,27
4	Drying	Floor of aspel/ soil/ mat	2,08	Floor of Plastic terpal	2,58
5	Milling	One pass	2,12	Double pass	2,07
6	Storing	Storage without pallet (not good aerasion)	3,25	Good Storage Practices (GSP)	2,00
	Totals of paddy losses		14,19		8,53

Recomendation of Postharvest technology package for decreasing paddy losses:

1. Without transportation of stover for threshing in the field (not at home)
2. Threshing whith pedal thresher
3. Milling with double pass type and equipped separator to improve the yield of the system configuration allows for necessary repairs mills.
4. Packaging storage system equipped with base wooden pallet for air circulation and moisture content of grain 14% (Table 20).

3.2. Evaluating existing prototype of farm machinery

In accordance with the TOR, TCE in this period makes paddy separator and burner of rice husk charcoal briquettes.

3.2.1. Prototype of farm machinery

3.2.1.1. Existing prototype of paddy separator machinery

- Postharvest handling are closely related to the increase in production is the aspect of paddy losses.
- The process of rice milling to increase rendement and quality of milled rice with double-pass system and through the process of cleaning grain (paddy cleaner), stripping grain leather (husker), the separation of paddy grain and brown rice (paddy separator), polishing (blower polisher) and the separation of head rice and broken rice(rice separataor).
- Small-scale rice milling systems generally with single pass (husker and polisher in one unit system tools, so no tools equipped separator that separates the paddy grain and brown rice. While using double-pass system is also not equipped with tools padyy separator. Use tool Paddy separator only on large-scale rice mills, as shown below. Equipment RPS-10A separator type is input capacity from 1 to 1.2 tons / hour, power required 1 HP, 180 kg weight and dimension (LxWxH) 1250 mm x 1025 mm x1115 mm. For small-scale mills do not use because the price is affordable and requires no electricity.

Figure 24. Brown rice sepataor type RPS-10A made in Japan

3.2.1.2. Existing prototype of rice husk charcoal machinery

- Charcoal as cooking fuel is very important for Madagascar. The majority communities Madagascar cooking with charcoal fuel plant Mimosa dar wood or pine. Making charcoal from wood fuels in the community created manually. Cooking fuel from fuel wood and charcoal from wood can damage the environment because it cut down so many barren land on slopes of over 45°.
- Utilization of rice milling by products rice husks can be made husk charcoal and charcoal briquettes. Equipment / machinery such as rice husk charcoal Cyclonic Husk Furnace Type AHF-250C can produce rice husk 5-15 kg / hr. Specifications machine's energy needs 250 kw, hot air temperature 70-300^{o}C, chaff needs 20-60 kg / h, temperature 30^{o}C husk charcoal, total electric power 4.5 HP, weighs two tons and dimension p = 1.15 mx xl xt 1.15 mx 4.9 m. For small-scale farmers and the price is affordable and requires no electricity (Figure 25).

Figure 25. Cyclonic Husk Furnace Type AHF-250C made in Indonesia

3.2.1.3. Prototyping Manual Paddy Separator

- Paddy separator has been developed on a small scale rice mill in West Java - Indonesia.
- The system device works is by using a 10 mm mesh sieve on a gravity system can separate paddy grain and brown rice.
- Compared with the machine pady Vitrabing separator system is more expensive because the metal material and using electric energy compared Manual Paddy separator materials from wood.
- Prototype Manual Paddy separator is an improvement of existing Manual Paddy separator can be set as desired tilt angle and the filter can be replaced with mesh trending, so it can be used for multiple functions. Separator can be used as a Paddy separator, Rice Separator and Brand Separator only change filter. as Figures 26 and 27.

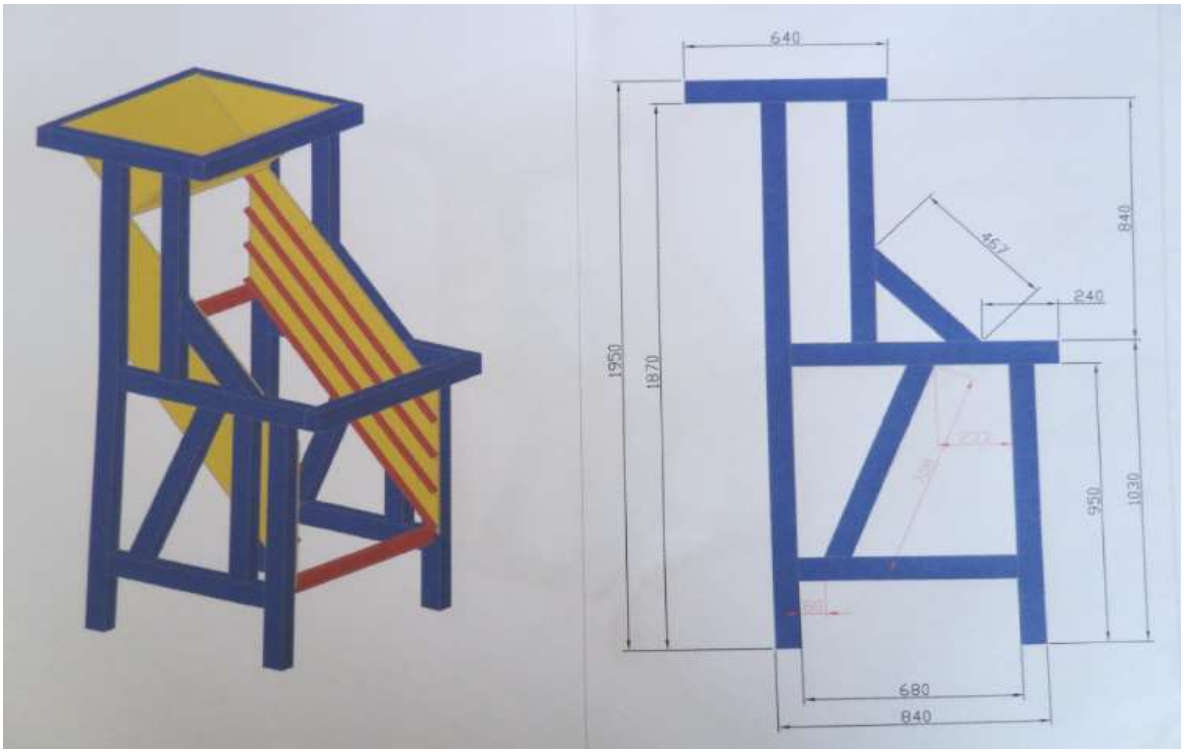


Figure 26. New Prototype of Manual Paddy Separator

(1) (2)

Figure 27. Prototype of Manual Paddy Separator from wood (1) and metal (2)

Table 21. Spesification of new Prototype Manual Paddy Separator Multifunction

Name of machine	:	Manual Paddy Separator-Wood	Manual Paddy Separator-Metal
Model	:	Gravitation system manual operated	Gravitation system manual operated
Suitable for crop	:	Paddy and rice	Paddy and rice
Input capacity	:	1 – 1,2 ton/hour	1 – 1,2 ton/hour
Material	:	Wood	Metal
Weight of machine	:	200 kg	61 kg
Dimension			
- Length	:	128 cm	1400 mm
- Width	:	110 cm	1000 mm
- Height	:	200 cm	1775 mm

Tool paddy separator consists of three components, namely the tool body, body parts sieve, and the material hopper income. Body parts of the chart timber tool length 128 cm, width 110 cm, height 200 cm. Body parts sieve using a wooden board or plywood material, zinc plate, stailesteel wire sieve of mesh size 10 mm (sieve paddy separator), mesh 3 mm (rice separator) and 2mm mesh (small broken rice separator). Part of the material hopper wooden board / plywood and zinc.

3.2.1.4. Prototyping of Rice Husk Manual Burner

- Tools of Rice Husk charcoal Manual Burner is widely developed in West Java - Indonesia to make rice husk as a mixture to hydroponic plants.
- Prototype Manual Rice Husk Burner was created in Workshop CFAMA to be developed in Madagascar as an alternative to replacing wood charcoal because it can be made easily, cheaply and quickly configurable process (4 hours) than in making charcoal (4 days).
- Prototype Manual Burner Rice Husk as Figure 5 and 6 below.

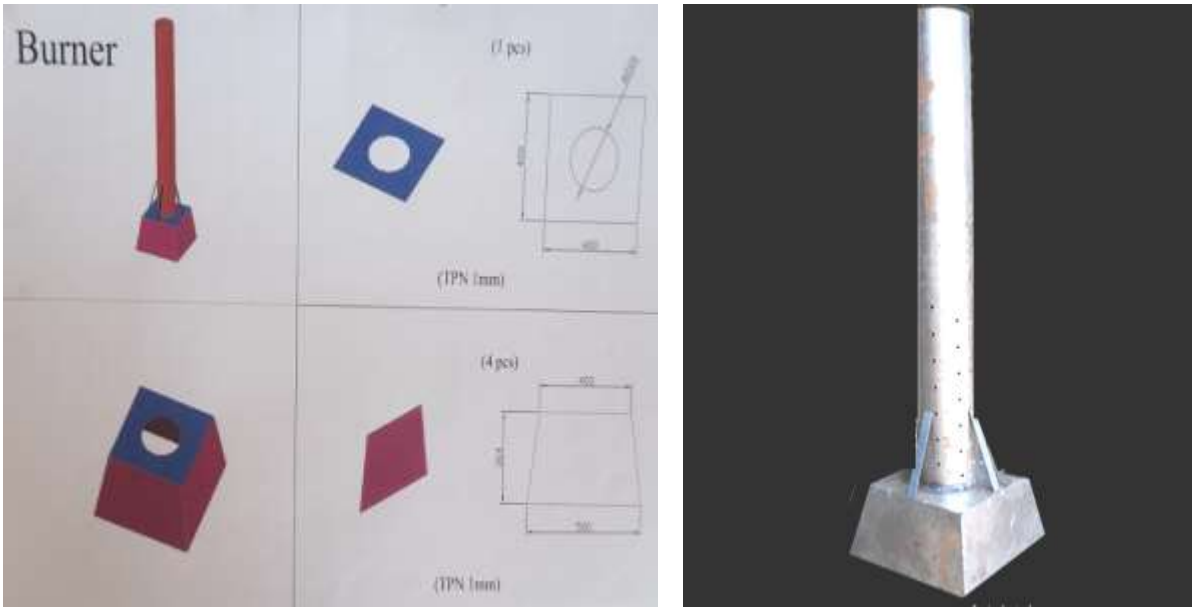


Figure 28. Prototype Manual Rice Husk Burner

Table 22. Spesification of Rice Husk Charcoal Burner

Name of machine	Manual Rice Husk Burner
Suitable for crop	Rice husk of the Paddy
Input capacity	100kg rice husk / 4 hour
Weight of machine	10 kg
Dimension	
- Length	40 cm
- Width	40 cm
- Height	200 cm

3.2.1.5. Prototyping of husk charcoal briquettes press machine

Figure 29. Prototype 1A of Pressing machine for charcoal briquettes

Figure 30. Prototype 1B of Pressing machine for charcoal briquettes

Table 23. Spesification of Pressing machine for Rice Husk Charcoal Briquettes

Name of machine	Pressing machine for charcoal briquettes
Suitable for crop	Rice husk of the Paddy
Input capacity	25 pc charcoal briquettes
Weight of machine	37 kg
Dimension	
- Length	540 mm
- Width	480 mm
- Height	1450 mm

3.2.2 Testing and performance of prototype

3.2.2.1. Performance of paddy separator multi function

- Paddy Separator serves as a multipurpose (separating paddy grain and brown rice), as Rice Separator (separates the head rice and broken rice / small broken rice) and as Brand Separator (separates bran with small broken rice).
- Application of this tool for each function (as paddy separator, rice separator and brand separator) of different sizes (mesh), the number and angle of slope (elevation) sieve. As Paddy Separator required sieve size of 10 mm, the number of sieve 3 pieces and 48^{o} angle. As Rice Separator screen diameter 3 mm, sum of screen 3 levels. Stop

elevators until 48^{o} becouse preferency of consumen for good quality (grade 3 SNI of Rice, broken rice in head rice 14.2% (Decrease) (Table 24).

- To increase of of quality can increase of the rice price using separator. Result of broken rice from the separator can used for materials of rice flour and price more expensive than broken rice and small broken rice.

Table 24. Test of Broken Rice Separator (October 25th, 2012)

Treatment		Unit	Broken rice	Head rice	Totals	Broken rice in Head rice
Elevator 55^{o}	1 time replication	(g)	9	344,3	353,3	156,67
		(%)	2,54	97,45		45,50
	2 times replication	(g)	19,2	333,2	352,4	146,37
		(%)	5,44	94,55		43,92
Elevator 53^{o}	1 time replication	(g)	80,3	271,4	351,7	85,27
		(%)	22,83	77,16		31,41
	2 times replication	(g)	104,9	246,2	351,1	60,67
		(%)	29,87	70,12		24,64
Elevator 48^{o}	1 time replication	(g)	127,1	222,8	349,9	38,47
		(%)	36,32	63,67		17,26
	2 times replication	(g)	135,1	214,3	349,4	30,47
		(%)	38,66	61,33		14,2

Table 25. Test of Broken Rice Separator on elevator 48^{o}

Treatments	Replication	Broken rice	Head rice	Broken rice in Head rice
1 time reprication	1	5,25	93,46	7,06
	2	4,57	94,07	8,89
	3	4,67	94,13	10,81
	4	4,98	95,01	7,74
	5	4,01	93,74	11,11
	Average	4,69	94,08	9,12
2 time reprication	1	8,72	99,12	2,56
	2	8,33	91,66	4,47
	3	6,97	93,02	3,31
	4	6,25	93,75	3,92
	5	4,0	96,04	3,95
	Average	6,85	94,71	3,64

Figure 31. Test of rice Separator

3.2.2.2. Performance of Manual Rice Husk Burner

The results of testing the tool furnace (burner) on charcoal husk, 2 replications indicate that production capacity of 100 kg dry rice husk/ 4 hours / processes and produce rice husk charcoal yield 43.64%. Raw materials rice husk at 12.8% moisture content produced rice husk at 17.75% moisture content, ash content and grain unburnt 0% (Table 26).

Table 26. Test of rice husk charcoal burner

Observation	Contents		Average
	1	2	
Moisture content of rice husk (%)	12,10	13,50	12,80
Weight of rice husk (kg)	95,00	96,00	95,20
Moisture content of rice husk charcoal (%)	17,90	17,60	17,75
Weight of rice husk charcoal (kg)	43,00	41,25	42,12
Recovery / rendemend (%)	44,32	42,96	43,64
Ask content (%)	0,00	0,00	0,00
Paddy that not burned (%)	0,00	0,00	0,00

Figure 32. Test of rice husk charcoal burner

The trial results briquettes press equipment manual on making rice husk charcoal briquettes showed that the use of the adhesive (glue) yield a different result in a different the rendement of rice husk charcoal briquettes. With the concentration of adhesive / glue (adhesive tapioca / cassava flour / clay : water = 1:9) and the concentration of briquettes (glue : charcoal husk = 2: 7) produces briquettes husk charcoal rendement of 100-183%. The rendement of rice husk charcoal briquettes on average by 142.6% and 15.7% moisture content. Production capacity use the appliance manual press at 150 g/90 min (100 g / h or 4 pieces of briquette weighs 50 grams / piece) (Table 27).

Table 27. Test of rice husk charcoal briquettes

Treatment	Con-centration	Weight CRH (g)	MC CRH (%)	Weight BCRH (g)	MC BCRH (%)	Recovery BCRH (%)	Time (menit)	Capasity (g/menit)	Sume of briquette (pc)	Size of briquettes (mm)		Weight briquettes /pc (g)
										Ø	T	
Tapioka	1 : 7	150	18,6	200	15,5	133	90	150/90	4	50	100	50
	2 : 7	150	17,8	275	16,7	183	90	150/90	4	50	100	50
	3 : 7	150	17,4	260	14,7	173	90	150/90	4	50	100	50
	Avg				15,6	163						
Cassava flour	2 : 7	150	18,6	150	14,5	100	90	150/90	4	50	100	50
	3 : 7	150	17,8	175	14,2	116	90	150/90	4	50	100	50
	4 : 7	150	17,4	200	15,0	133	90	150/90	4	50	100	50
	Avg				14,5	116						
Clay	2 : 7	150	18,6	200	17,0	133	90	150/90	4	50	100	50
	3 : 7	150	17,8	250	17,0	166	90	150/90	4	50	100	50
	4 : 7	150	17,4	250	17,2	166	90	150/90	4	50	100	50
	Avg				17,0	149						
Average					15,7	142,6						

CRH = Charcoal of rice husk
BCRH= Briquettes of rice husk charcoal
MC = Moisture content

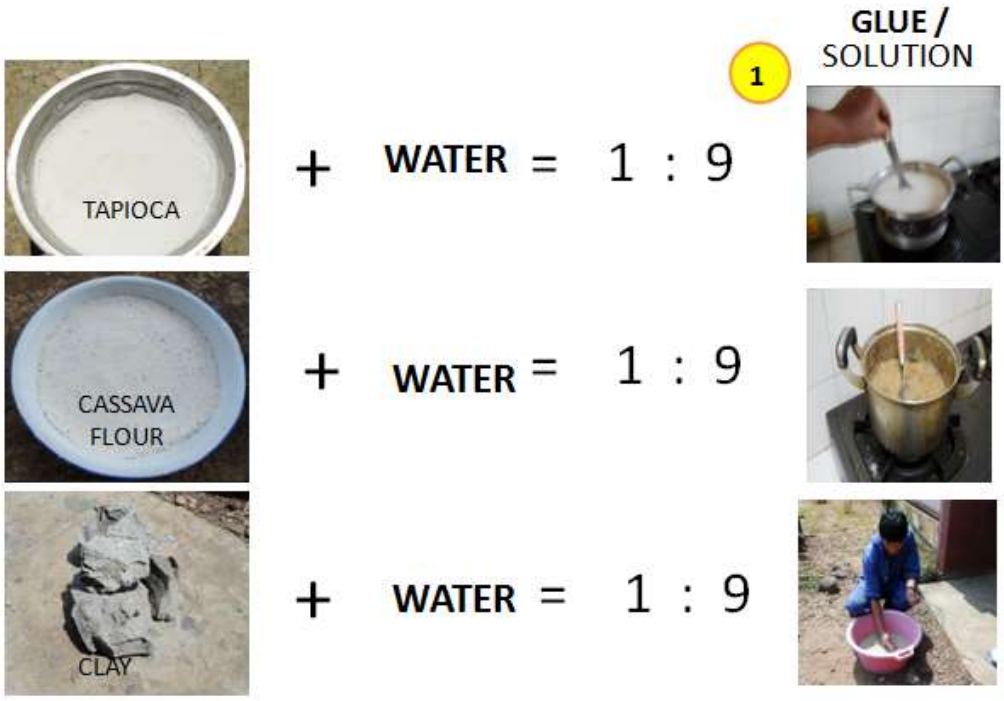


Figure 33. Concentration of glue matrials (tapioca or cassava flour or clay) to make glue used produce charcoal briquettes

Alat press briquettes manual

The glue of tapioca (Cassava Starch)

The glue of clay

The glue of cassava flour

Figure 34. Concentration of glue and rice husk charcoal used produce charcoal briquettes

Test results husk charcoal briquettes for cooking 2 liters of water indicates that the adhesive / glue clay takes 55 minutes, 0.02 kg energy requirements, costs 17.42 Ar, the temperature of the water 246^{o}C and not smoke than fuel wood, wood charcoal and LPG more expensive and smoky (Table 3). With the price beriket 150Ar/kg husk charcoal and wood charcoal 200Ar/kg then use adhesive clay (B /C ratio 1.98) is more beneficial than the adhesive tapioca (B / C ratio of 1.28), cassava flour (B / C ratio 1.44) and wood charcoal (B / C ratio of 1.30) (Table 28 and 29).

Table 28.Test of rice husk charcoal briquettes and cost of energy for water cooking of 2 liters

Materials of energy	Time (minutes)	Need of energy(kg)	Cost (Ar/kg)	Hot air Temperature (^{o}C)	Smoke condition
Gas (elpiji)	8	0,033	206,2	277	Not
Wood charcoal of Mimosa	30	0,073	28,6	247	Bit
Wood chrcoal of Pinus	32	0,071	27,8	278	Bit
Wood		0,440	117	151	Many
Briquettes of rice husk charcoal with tapioca glue	40	0,206	27,48	239	Bit
Briquettes of rice husk charcoal with cassava flour glue	47	0,221	26,43	253	Bit
Briquettes of rice husk charcoal with clay glue	55	0,202	17,42	246	Not

Tablel 29. Economic analysis of rice husk charcoal briquettes t

Discription	Rice husk charcoal	Briquettes of rice husk charcoal with tapioca glue	Briquettes of rice husk charcoal with cassava flour glue	Briquettes of rice husk charcoal with clay glue	Wood chrcoal
Price (Ar / kg)	85,53	150	150	150	200
Capacity (kg/hour)	280	296	296	296	112,5
Cost of labour (Ar/procces)	3.000	3.000	3000	3000	18.000
Cost production (Ar/kg)	40,9	116	104	75,70	153
Processing time (days)	5 hours	2	2	2	4
B/C rasio	2,09	1,28	1,44	1,98	1,30

Figure 35. Test of rice husk charcoal briquettes and cost of energy for water cooking of 2 liters

3.3. Transfer technology

technology transfer has been done through training and demonstration of the artisan and the staff goverment (DRDR) in the highland region of Madagascar rice postharvest technologies and the development of agricultural machinery.

3.3.1. Demostration of Paddy separator

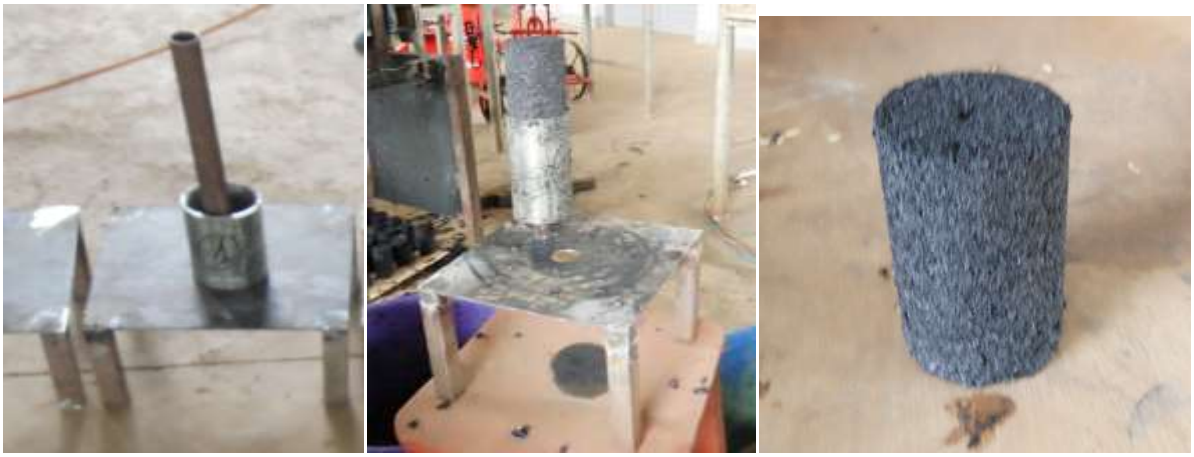
Demonstration paddy separator has been done to entrepreneurs rice mills in Antsirabe.

Figure 36 . Demontration of new prototype Paddy Separator (a) material wood and (b) material metal in the CFAMA and Rice Milling, Antsirabe

3.3.2. Demontration of Bricket Charcoal Burner

Demonstration rice husk charcoal in Bongolava and Antsirabe

Figure 37. Demonstration of rice husk charcoal in Bongolava and Antsirabe



Demonstration of rice husk charcoal briquettest using with Manual Pressing capasitas one briquettes per process in Antsirabe

Figure 38. Demonstration of rice husk charcoal briquettest using with Manual Pressing capasitas 25 briquettes per process in Antsirabe

3.3.3. Training of Approoriate Agriculture Machinery

3.3.3.1. Training of manhine for Artisan

1. Making husk charcoal burners at Artisan

Figure 39. Artisan in Vakinankarata region

Figure 40.Artisan in Bongolava region

2. Making Paddy Separator at Artisan

Figure 41.Artisan in Vakinankaratra region

3.3.3.2. Training of Postharvest for Goverment

Rice postharvest technology training to DRDR in five regions Madagascar on November 13-15, 2012 held at CFAMA Papriz Project Antsirabe 90 people with the material:

1) Feed-back fertilization on soil test model sites (Prof. Yamaguchi and Miss Hoby);
2) Theoretical Course on product improvement and post-harvest demonstration of the production of charcoal from rice hulls (Suismono Mr. and Mr. Ando CFAMA);
3) Methodology and tools for monitoring / evaluation of the technical package (Staff Association of Rural Development Actions Tsiroanomandidy);
4) Conference on the seed sub-sector (chaired by Ms. Ketamalala).

Table 30. Scledule Training of Rice Postharvest Technology (November 13-15, 2012

Dates/Groupes	Sous-Groupe A	Sous-Groupe B	Sous-Groupe C
Le 12/11/2012 Lundi	**Déplacement**		
Le 13/11/2012 Mardi **9 :30 – 12 :30**	**Conférence sur le sous-secteur Semencier** **Thèmes :** **1)Production de la semence de base ; 2)Pérennisation de la prestation de service contrôle ; 3)Commercialisation/marketing de la semence certifiée ; et 4)Sensibilisation/vulgarisation de la semence de bonne qualité.**		
14 :00 – 17 : 30	**Suivi/ Evaluation (AADR)**	**Test de fertilisation (Prof. YAMAGUCHI)**	**Traitement après-récolte (Mr. Suismono)**
Le 14/11/2012 Mer. **9 :00 – 12 :30**	**Traitement après-récolte (Mr. Suismono)**	**Suivi/ Evaluation (AADR)**	**Test de fertilisation (Prof. YAMAGUCHI)**
14 :00 – 17 : 30	**Test de fertilisation (Prof. YAMAGUCHI)**	**Traitement après-récolte (Mr. Suismono)**	**Suivi/ Evaluation (AADR)**
18 :00 – 19 :30	**Réception**		
Le 15/11/2012 **9 :00 – 11 :30**	**Discussion de chaque région cible et présentation du plan d'actions sur les quatre**		
11 : 30 – 12 :00	**Cocktail**		
Après-midi	**Déplacement**		

Materies of training Postharvest Technology :

1) Method of paddy losses measurement (Theory and practicies)
2) Method of rice quality analysis (Theory and praticies)
3) Demostration the paddy separator for to improve rice quality
4) Demontration processing of rice husk charcoal briquettes

Figure 42. Training of Papriz workshop in CFAMA Vakinankarata region

3.3.3.3. Workshop Papriz

The survey results of paddy losses and rice quality in highland Madagascar presented at a workshop held on February 15, 2013 by JICA with Papriz-Topic "Evaluation Of Paddy losses and Rice Quality in Highland In Madagascar", a place Nanisana, Antananarivo.

Table 31. Workshop Scledule of Paddy Losses and Rice Quality in Highlan Madagascar February 15, 2013

Timing	Themes	Speakers
09:00 – 09	♣ Open h05 (5min)	DGT
09: 05 - 09:25	♣ Presentation on "Evaluation of paddy losses and rice qualities in the highlands of Madagascar" (25 min)	M. Suismono
09: 25 - 10: 10	♣ Discussion (45 min)	DGT / M.Kabaki
10: 10 - 10: 15	♣ Closing (5min)	

IV. FACTOR THAT HAVE PROMOTED THE PROJECT

4.1. Impact

- TCE activities support facilities in the development of a prototype of CFAMA agricultural machinery.
- Good cooperation from all staff CFAMA Director, Assistant TCE and TCE Technician for carrying out activities in CFAMA.
- Good coordination with Papriz Project always sopporting Bugged from JICA for the success of the activities TCE. Coordination with DRDR and Coordinators in each region are very helpful Papriz TCE activities in the field.
- Assist DRDR (goverment) in measuring paddy losses and rice quality analysis, as well as trying to give the technology package to reduce post-harvest losses, and improvement of rice quality.
- Farmers become a consumer and artisan producer of appropriate farm machinery.

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4.2. Sustainability

- Result of the workshop showed that paddy losses during postharvest losses large (14.19%) and rice quality is still below standard (broken rice more 20% and milling degree less than 80%) that need socialization measurement paddy in all regions of the central rice production (highland and Lowland) in Madagascar.
- To improve the rendement and rice quality need to be a pilot (Pilot Plan) Rice Mill Double Pass to support the revitalization programme of small-scale rice mill (capacity 1-5 tons / day) and intermediate (production capacity of 5-10 tons / day).
- In providing assurance of product quality from artisan production of agricultural machinery required Certification of Engineering product under the supervision / coordination CFAMA. CFAMA also need improved management Workshop (Engineering Laboratory) through the implementation of ISO 17025-2005 for accreditation.

V. CONCLUSION

During the six month period (August 2012 - February 2013), TCE activities in Madagascar has resulted in:

- Preliminary data losses and quality of paddy/rice in highland (5 regions Vakinankaratra, Bongolava, Alaotra-Mangoro, Itasy and Analamanga region) in Madagascar.
- Four tecnical Guide (Technical Guide of Measurement Paddy Losses, Rice Quality Analysis, Paddy Separator and Charcoal burners and Charcoal briquettes Pressing Machine).

  Four the prototype of machinery (Manual Wood Separator for paddy, Manual Metal Separator for Paddy, Rice husk Burner and briquettes Pressing machine).
- Transfer of technology through training "Measurements of losses and Rice Paddy quality analysis" on DRDR and coaching tool manufacture Paddy Separator and Bricket Burner on artisan.
- Four the prototype of machinery (Manual Wood Separator for paddy, Manual Metal Separator for Paddy, Rice husk briquettes Burner and Pressing Machine). Transfer of technology through training "Measurements of paddy losses and Rice quality analysis" on DRDR and coaching tool manufacture Paddy Separator and briquettes Burner on artisan.
- To conduct dissemination and demonstration of measurement paddy losses in DRDR Bongolava and Vakinankaratra, as well as demonstrations of charcoal and charcoal briquettes in Bongolava.
- Provide Workshop "Evaluation of paddy Losses and rice quality in Highland Madagascar" to the Ministry of Agriculture and Papriz / JICA Project Madagascar.

VI. REKOMENDATIONS

6.1. To the Ministry of Agriculture

- Application of technology package to decrease paddy losses with using new variety (not threshe), plant condition has 80% paddy grain with yellow color and dry soil in the field, threshing in rhe field with pedal thresher and size of floor minimum 8 m x 8 m, sun drying with plastic terpal, rice milling with double pass system, and Packaging Storage Syatem and room of paddy grain storage good aeration with pallet and moisture content of 14%.
- Technical Guide of Paddy losses dan Technical Guide of Rice Quality can used reference by DRDR to activity the mesurement of paddy losses in the field. In the future nexc programme need the evaluation of paddy losses and rice quality in the central area of rice production (highland and lowland area) in Madagascar .
- To increase rendement and rice quality need the Revitalisation programme of rice milling with Double Pass system.

6.2. To JICA

- Tecnology Packet with the milling process configurasi “Cleaner-Husker-Separator-Polisher-Polisher-Grader (C-H-S-P-P-G) and Double pass system in Rice Milling Unit small scale” can decrease the milling losses and to increase rendement and quality for rice.
- To support these activities required a pilot unit (Pilot Plan) "Rice Milling double pass system on a small scale" and Laboratory Quality Rice "which applies the quality management system. Therefore the support of Papriz-JICA Project of the facility equipment for rice milling and laboratoium of rice quality analysis is expected. CFAMA need coaching workshop management so as standard agricultural machinery products.

VII. FEASIBILITY FOR THE NEX PROGRAMME

- For the period of March to September 2013 TCE and Papriz have a common perception that focus on improvement activities rendement and rice quality in Rice Milling Pilot Plan Double pass on a small scale. Modification of polishing machine and configuration polishing of milling process will improve the rendement and rice quality. Improved system of rice polisher machine with stainless steel, giving blower and water spryer injection system can improvement rendement and rice quality.
- Still needs evaluation paddy losses on harvest season (between the months of April to June) as in Itasy and Alaotra region has not been measured paddy losses, only Mangoro area.
- Assist CFAMA preparation of documents for the application of ISO 17025-2005 accreditationin the CFAMA workshop and quality assurance for machinery products to consumers (farmer).