FINAL REPORT ON

PROJECT FOR RICE PRODUCTIVITY IMPROVEMENT IN CENTRAL HIGHLAND IN THE REPUBLIC OF MADAGASCAR

June 2012

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ACKNOWLEDGEMENTS

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Antsirabe, June, 2012

Joko Pitoyo
Indonesian Expert
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<tr>
<td>CFAMA</td>
<td>Centre de Formation et d’Aplication du Machinisme Agricole/Training and Application Center for Farm Machineries</td>
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<tr>
<td>CMS</td>
<td>Centre Multiplicateur de semences/Seed Multiplication Centre</td>
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<tr>
<td>C/P</td>
<td>Counter Part</td>
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<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
</tr>
<tr>
<td>GPS</td>
<td>Group of farmer Producing Seed</td>
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<td>JICA</td>
<td>Japan International Cooperation Agency</td>
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<td>MINAGRI</td>
<td>Ministry of Agricultural</td>
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<tr>
<td>PDM</td>
<td>Project Design matrix</td>
</tr>
<tr>
<td>PAPRIZ</td>
<td>Project for Rice Productivity Improvement in Central Highland in Madagascar</td>
</tr>
<tr>
<td>RTMC</td>
<td>Regional Technical Management Committee</td>
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<tr>
<td>TCE</td>
<td>Third Country Expert</td>
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I. THE OUTLINE OF THE PROJECT

1.1. Background and content of technical cooperation.

The Ministry of Agriculture (MINAGRI) is responsible of promoting better environment for the rural development. There are actions taken to reduce poverty, to reach the food security, to improve income of rural people, to initiate profitable agriculture, to create jobs and to invest in food and agriculture system. In this context, Madagascar aims at increasing rice production.

For the same purpose, JICA started the technical cooperation project in January 2009 for 5 years: “the Project for Rice Productivity Improvement in Central Highland in Madagascar”. The dispatched third country experts (TCE) will work as an expert within the Project aiming at the increase in rice productivity in model sites. The project’s target area is five regions in Central Highland of Madagascar. Within five Regions, the three (03) regions (Bongolava, Alaotra Mangoro and Vakinankaratra) are the focal regions and one model site is selected by region to be implemented from the early stage of the Project for technology development and for seed multiplication under typical agro-ecological conditions. The outcomes in the three model sites will be disseminated in all five Regions.

Toward the achievement of the project’s purpose, development and promotion of appropriate agricultural machinery is one of the important elements which consist of the integrated technical packages for rice productivity improvement. The experts are expected to contribute to the Project on the development and technical transfer for certain agricultural machines.

1.2. Purpose and content of the project

Productivity of rice products increases at model sites of the Project

1.3. Project name, site and government agencies involved

- Project name : Project for Rice Productivity Improvement in Central Highland in Madagascar” (hereafter referred to as “Project”)

1
- Project site : since 2009 three (03) regions (Bongolava, Alaotra Mangoro and Vakinankaratra), since 2011 added two (02) regions (Itasy and Analamanga)
- Government agency : Ministry of Agriculture,(MINAGRI)
- Counterpart agency : Agricultural Machinery Training and Application Center of Antsirabe (CFAMA)

The dispatched TCE will work as an expert within the JICA’s technical cooperation project: “the Project for Rice Productivity Improvement in Central Highland in Madagascar” which covers the five (05) regions (Bongolava, Alaotra Mangoro Vakinankaratra, Itasy and Analamanga).

An office will be provided to the expert in CFAMA located in Antsirabe in Vakinankaratra. He will visit five (05) regions of the Project target to know farmer’s needs in small agricultural equipment, to undertake field test of the prototype and to see small workshops in rural areas.

1.4. Scope of Services to be provided by expert

The two experts specialized mainly in agricultural mechanization with appropriate technologies shall be assigned the following duties.

1) Both experts shall have the following common duties:

- collect information on existing machine/tools
- assess need of farmers in three focal regions
- evaluate potential of mechanization of farming operation
- identify types and specification of machine/tool to meet their needs
- undertake filed test and data collection for develop machine/tool with farmers and local manufacturers
- provide technical support on appropriate machinery use for DRDR (regional stations of MINAgri) staff and extension agents.

2) The expert first to be dispatched shall have the following specific duties:

- improve the development equipment (seeder and weeder for upland rice) base on the field test with farmers,

- train local manufacturers about manufacturing appropriate machinery in three focal regions,

- recommend the project for a strategy and possible actions to promote local machinery production.

3) The expert second to be dispatched shall have the following specific duties:

- investigate present situations of post-harvest of rice in three focal regions.

- propose the direction of systemized mechanization of harvest and post harvest.

- develop the prototype of post-harvest machineries

- recommend the Project for a strategy and possible actions to promote local machinery production.

II. METHODE

2.1. Making schedule activity and budget planning

Schedule activity has been proposed base on project design matrix (PDM) and Term of Reference for appropriate farm machineries and also match with schedule of TCE farm machineries dispatch plan. Budget planning was proposed within period 3 month, 1st budget planning start Dec 2011 – February 2012, 2nd budget planning start March 2012 – May 2012.

The dispatch period is carried out from: 7 Dec, 2011 – 8 June 2012
2.2. Evaluating existing prototype of farm machinery

The objective of activities is to evaluate several kinds of farm machineries. The evaluation are concerning on technically aspect and economically aspect. The detail of objective is here:

1. To test the machine and equipment therefore will get the data specification and dimension, performance test such as capacity input and output per hour, comfort ability for operator and ergonomic side, conformability for transporting and reliability, durability of machine.

2. To evaluate economically of machine, which consist of purchase cost, fixed cost, variable cost and operational cost

The some prototype is upland weeder, seeder for upland rice. There two type weeder made by local artisan in Antsirabe and seeder drill seeing type made by local artisan in Antananarivo. The method to know technical performance is directly operated
the machine. The place for testing for weeder upland paddy was on CFAMA upland paddy around January 2011. The seeder machine produce by one artisan In Antananarivo were testing on place of local artisan. There was also one seeder machine single row imported from Japan also be tested at CFAMA paddy field.

To design and developing the prototype of farm machinery, TCE should be consider many aspect such as an availability of local material, suitability to the land condition, affordability to the low level farmer, the level of technology are match to the recent level and knowledge of local artisan. For the beginning step TCE used AutoCAD software to simulated and designing prototype. To fabricated prototype TCE collaborated with C/P and technician CFAMA and the facilities was used new CFAMA workshop which quit complete with some new tool facilities.

2.3. Input of the project

Input Japanese side

1. Expert
1.1. Long term expert (depend on necessity)
   Chief advisor/Agricultural Development, project Coordinator, Dissemination, Rice production, Farm Management.
1.2. Short term expert (depend on necessity)
   Agricultural machinery, farmer organization, Postharvest, IEC, Agricultural Economic/Marketing (detail of field, number and term of experts shall be determined during the process of detail design of the Project)
1.3. Third Country Experts (ex. Agricultural Machinery).

2. Training
   Training in Japan and or third country

3. Equipment delivery
   - Vehicle, office equipment, ETC
   - Other necessary input, expenses.
Input Madagascar side

1. Human resources, Counterpart and administrative personal
2. Building, office spaces and necessary facilities for the project activities
3. Local cost (operational cost for the project implementation)
III. RESULT

3.1. Evaluating existing prototype and technologies of farm machinery

The TOR should be follow by TCE in this work period is mainly improvement and development of seeder and weeder for upland rice. The packet techniques of upland paddy are also one of the components packet technique should be developed by papriz project. Even though not so ready yet like packet technique of wet land paddy but Papriz has been started developed it. The one component of it is seeding system, the seed for upland paddy there are many variety available in Madagascar such as FOFIFA 62, FOFIFA 133, FOFIFA 154, FOFIFA 172 Chamrong dhan, NERICA 3, NERICA 4 Sebota 70 etc.

The land preparation, two times of tillage with plough and one time of pulverization and leveling with harrow should be conducted before seeding. The first tillage with plough is conducted in May ~ June after previous rainy season cropping while the soil is wet and soft. The second is to be done after the beginning of rainy season (20 – 30 days before seeding). At the same time dolomite and farmyard manure are incorporated into the land. Harrowing is conducted 1 – 2 days before seeding.

Optimum time of seeding in Madagascar up land rice is between middle November and middle December after the start of rainy season. Drill seeding with 20 ~ 25 cm of the distance between row by seeding rate 70 ~ 80 kg/ha. Another recommendation system is by hill seeding with the distance 20 x 20 cm and number of grain 4 – 5 grain/hill equal seeding rate 40 – 50 kg/ha of seed. Chemical fertilizer is applied before seeing on the same ditch (drill seeding) or hole (hill seeding) at the deeper position (5 – 10 cm soil surface) followed by the covering with soil to avoid the adverse effect on the germination of upland rice. Seeding is conducting by seeder or hand with the depth 4 – 5 cm. Seed are covered with soil an pressed by toe to prevent washing away by torrential rainfall. Preparation of small nursery bed in a corner of the field is recommended to provide seedling to be planted in missing hill at 15 – 20 days after seeding (DAS) Weed control (weeding) is recommended to be done for 2~3 times with the first conduct at 15 ~20 DAS the second at 25 ~30 DAS. The third control is conducted when the occurrence
of weed is observed thereafter (if necessary) Weeding is conducted by upland weeder or hoes. Uprooted weed should be remove from field to prevent regeneration. Pre-germination and or foliar application herbicides can be used as a mean of weed control.

The prototype of drill seeding machine in Madagascar could find on some local artisan. It used metering device vertical type made by aluminum, the performance of this machine sometime the seed of paddy stuck on metering because friction between wall of metering and seed. The distance of seed within row also are irregular and may get difficulties during weeding time.

Figure 1. Prototype drill seeding machine manual type single row made by Madagascar local Artisan

Another prototype of drill seeder is drill seeder made in Japan single row one product of Gombei company drill seeder HS 300 which in try introduced by papriz as alternative prototype for upland seeder in Madagascar on April 2012.
The upon drill seeder was very good on performance but the distance within the raw was not clear exact therefore the farmer will get difficulties during weeding time. The result of growing paddy which sawing by this prototype is showed below. The test was conduct at CFAMA Atnsirabe upland paddy.
The other considering to developing and introducing this prototype is about complicated construction that also need some critical metering part made by plastic which difficult to be construct in Madagascar.

The other machine should examine and evaluating related to the development machine for support upland rice is upland weeder. The photo below is one of the prototype of upland weeder which produce by local artisan in Antsirabe.

![Prototype of Upland weeder produced by local artisan Antsirabe Madagascar](image)

**Figure 4. Prototype of Upland weeder produced by local artisan Antsirabe Madagascar**

The result after testing this upland weeder are the moving device which used star wheel without rim make the part get easy to stuck with moist soil or even some small stone, and also because size of star well moving devices are too small the machine tend to go deeply on the soft soil condition.

The existing condition of machinery that even does not include on the TOR of this period is about pedal threshing machine. Some farmer on some area already customized with pedal thresher but some of them in another area are don’t have capacity to purchase because the price still to high to afford for them. In this case TCE have curiosity and initiative to design low cost and portable pedal thresher and also easy to be produce by local artisan even on the country side.
3.2. Prototyping farm machineries

The prototype of farm appropriate machineries is started by make concept design and also make consideration which is later on the product will accepted and could be exist and also wake balance demand and supply between farmer as customer and local artisan as producers.

3.2.1. Prototyping Up land seeder for rice

Finally TCE found some prototype of rolling injection seeder but little bit difference compare with rolling injection seeder design by IRRI Philippine. This rolling injection prototype was consist 6 punchers and opener and diameter of roller 36 cm, therefore distance of seed within row theoretical more less become 20 cm = (36 cm x 3.24)/6. TCE try to test
and analyzed to be able make by local material and of course should be match with papriz recommendation of packet technique of upland paddy.

Figure 6. The design of prototype new rolling injection seeder

Figure 7. Photo of new prototype of rolling injection seeder machine
### Specification of new Prototype Rolling injection seeder for upland:

**Name of machine** : Rolling injection seeder for upland  
**Model** : 1 row manual operated  
**Suitable for crop** : up land paddy  
**Delivery of seed** : 4 – 10 grain per hill (adjustable), by distance within row ± 20 cm  
**Operating speed** : 2 – 3 km/h  
**Field capacity** : 22 hour per ha, one operator.  
**Capacity of seed hopper** : 4 kg (max)  
**Weight of machine** : 7.5 kg  
**Dimension**  
- **Length** : 140 cm  
- **Width** : 45 cm  
- **Height** : 50 cm

The material to construct the prototype of new rolling injection seeder was easy to be find in some material store. Mainly the material are square pipe 2 x 3 cm for handle part, the metal plate size 16 mm x 2 mm for making frame of rolling injection, metal plate sheet is needed for make injector and opener and also for covering the rolling injection. The distributor is made by aluminum casting, to make it just order to the aluminum tool maker who as usually produce tool for house hold, of course by bring original pattern.

#### 3.2.2. Prototyping Up land weeder

As mention before design of upland weeder was modified from local prototype. Several parts should be modified especially on moving devices and shovel devices. The upland weeder was designed for distance among of row minimum 20 cm. The level technology is quite simple, and all material are available at some material store. The modification on mowing devices is done by added ring made by PVC tube which is available on the market diameter outside 132 mm and thickness 4mm therefore the weight of machine will not heavy and also get advantage the wet or moist soil will not adhesive to it. Therefore the machine will move and running well during operated on the field.
Figure 8. The design of upland weeder

Figure 9. Photo of prototype of Upland seeder
Specification of new Prototype Weeder for upland:

- **Name of machine**: Manual upland weeder
- **Model**: 1 row shovel type
- **Suitable row distance**: 20 – 25 cm
- **Width of shovel**: 12 cm
- **Operating speed**: 1.0 – 2 km/h (by push forward and reverse)
- **Field capacity**: 100 hour per ha, (one operator)
- **Weight of machine**: 6 kg
- **Dimension (total)**
  - **Length**: 115 cm
  - **Width**: 90 cm
  - **Height**: 30 cm

### 3.2.3. Prototyping Low cost pedal thresher for paddy

The design of low pedal thresher is base on condition of the existing cent technology of pedal thresher in Madagascar. Mostly artisan produce pedal thresher which is used gear as transmission system. It is become increase the price of pedal thresher and also needed strong frame and finally machine become heavy to bring to the paddy field. The operation of gear type pedal thresher mostly at of farm near by housing complex. Instead using gear 2 years ago TCE tried to design pedal thresher using sprocket and chain from spare part of motor cycle but it was not so helpful to solve the problem, because price cost still too height and could not afford by low level farmer.

By those condition above, TCE try to design low cost and light peal thresher. The transmission use bicycle part, but the construction system was deference as usual pedal thresher which mostly use for bar link system. By it normally the movement of up and down pedal lever which push by one foot operator will be transfer to the rotation movement and finally transmit to shaft of drum thresher. The un advantages of this transmission system is for operator become easy to fatigue because while standing by one foot another foot should be pushing the pedal that become unbalance and also need complicated transmission link part. The new purpose of transmission system is use cycling system like on bicycle, that mean operator will work by both foot like riding bicycle as the result the simple seat should be provide so the operator could enjoy operating the cycling pedal thresher.
Figure 10. Design of prototype low cost cycling pedal thresher

Figure 11. Photo of prototype low cost cycling pedal thresher
The main component of pedal thresher are frame construct by square pipe 3 x 2 cm which very light but quit strong, the drum thresher with diameter 32 cm and length only 550 cm quit simple but enough for operating even by double operator. The teeth of drum thresher are uses simple nail diameter 6 mm therefore easy to be find and make but useful to thresh the Madagascar paddy which is mostly have low scatter force therefore no need to use V type teeth. The transmission system are use big sprocket of bicycle 52 teeth and small sprocket 16 teeth, that all materials are easy to find even on county side of Madagascar. The simple seat is required as sitting of operator during operating this machine, the main requirement is height of seat more less 70 cm which is suitable for average adult operator, but anyway the size of seat could modified as preference of local operator.

**Specification of new Prototype Low cost cycling pedal thresher :**

<table>
<thead>
<tr>
<th>Name of machine</th>
<th>Cycling pedal thresher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>cycling type</td>
</tr>
<tr>
<td>Suitable of crop</td>
<td>paddy</td>
</tr>
<tr>
<td>Number of bar teeth on drum</td>
<td>10 units</td>
</tr>
<tr>
<td>Drum size (dint/length)</td>
<td>32 cm/ 55 cm</td>
</tr>
<tr>
<td>Output capacity</td>
<td>130 – 150 kg (depend condition of paddy and operator).</td>
</tr>
<tr>
<td>Weight of machine</td>
<td>22 kg</td>
</tr>
<tr>
<td>Dimension (total)</td>
<td></td>
</tr>
<tr>
<td>- Length</td>
<td>60 cm</td>
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<tr>
<td>- Width</td>
<td>63 cm</td>
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<tr>
<td>- Height</td>
<td>115 cm</td>
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3.3. **Testing and performance of prototype**

3.3.1. **Performance Up land seeder for rice**

The objective of test were; to test the performance of machine, to know capacity of machine (ha/h), to know seed delivery , to know the distance between row and distance of seed within rows.

The instrument were consist; Meter scale, digital balance 12 kg, digital balance 1,2 kg and stopwatch (chronometer).
The test of machine on laboratory was conducted by rolling the machine on concrete by mid of Feb 2012. The measurement were consist number of seed deliver on each metering which is total consist 6 metering. The variety of paddy using on this test is FOFIGA 161.

Table 2. The result test of laboratory test (number of seed deliver from injector) of new prototype rolling injection seeder

<table>
<thead>
<tr>
<th>No of injector</th>
<th>Number of grain deliver from injector</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 7 6 10 9 13 5 9 8 10 6 7 10</td>
<td>8.3</td>
</tr>
<tr>
<td>2</td>
<td>7 8 8 5 6 7 9 8 7 12 9 13 9 9</td>
<td>8.4</td>
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<tr>
<td>3</td>
<td>10 10 11 11 10 7 10 13 12 11 10 6 8</td>
<td>9.9</td>
</tr>
<tr>
<td>4</td>
<td>5 9 7 7 9 15 7 11 9 9 9 11 11 10</td>
<td>9.2</td>
</tr>
<tr>
<td>5</td>
<td>14 11 7 7 9 11 9 12 12 5 8 9 11 6</td>
<td>9.4</td>
</tr>
<tr>
<td>6</td>
<td>6 11 10 9 6 10 11 7 9 8 7 10 9 12</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Avg</td>
<td>9.0</td>
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After conduct such kind of laboratory test, the simulation about sawing rate could be make by simple calculation as mention below:

Simulation calculation, number of grain per ha

| Asumption weigh per 1000 grain | 25 gram |
| Distance of planting among of row | 20 cm |
| Distance of planting within row | 20 cm |
| Number of hill per ha | 250,000 hills |
| Total number of grain per ha | 2,252,976 grains |
| The weight of seed required/ha | 56324 gram |
|                            |          | 56.3 kg/ha |

From those simulation, can be get some prove that this machine quit match to the requirement of packet technique of upland paddy design by papriz which requested hill seeding system by distance 20 x 20 cm and sawing rate 40 – 50 kg/ha. But anyway this machine equipped with adjustment of delivery rate, therefore sowing rate could match exactly as requested depend on the variety and local condition.

The next test is the field test, as already mention before this machine supposed could get double direction both distance among of row and within rows like the tile ceramic floor pattern. As the theoretical its is possible but some time soil conditions are irregular so make
rolling of machine is some as theoretical and give result distance within row some time more than 20 cm or even less than 20 cm. Below here are the date of field test

Table 3. The result of field test (distance of seed among and within row) of prototype new rolling injection seeder

<table>
<thead>
<tr>
<th>No</th>
<th>1</th>
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<td>No</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
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<tr>
<td></td>
<td>Avg</td>
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<tr>
<td>Distance (cm)</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<td>20</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>21</td>
<td>19.36</td>
</tr>
</tbody>
</table>

Distance among of row (measured 11 days after sawing)

<table>
<thead>
<tr>
<th>No</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
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<td>22</td>
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<tr>
<td></td>
<td>Avg</td>
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<td>20</td>
<td>21</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

Distance within rows (measured 11 days after sawing)

<table>
<thead>
<tr>
<th>No</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<th>10</th>
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<td>Avg</td>
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<td>22</td>
<td>21</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

Figure 12. Photo of result field test (growing of paddy 12 days after sowing) by new prototype rolling injection seeder
The others performance on the field of new prototype rolling injection seeder is about number of seed deliver per hill and total sowing rate. Actually to measure and inspect on the field directly by checking one by one are very difficult and take time, therefore the method is by calculate deference weight of amount of seed on the hopper of machine before and after operated, and by know the area of sowing could easy calculated sowing rate and average number of seed per hill. The machine it was tested on area 5,24 mt x 23 mt = 124,2 mt$^2$ or equal 3105 hill (assumed distance among and within row 20 cm), the total weight of sowing seed was 0,85 kg therefore sowing rate equal 68,43 kg/ha and number of sowing seed per hill equal 10,9 grains/hill (assumed weight per 1000 grains = 25 gram).

### 3.3.2. Performance Up land weeder

The objective of test of upland weeder was mainly to know the functional of component of prototype. It was difficult to test the performance of upland weeder and effect of using...
weeder to the growing of upland paddy on the reality due to the season and time was not suitable.

**Table 4. Field test of working speed of prototype upland weeder**

<table>
<thead>
<tr>
<th>No</th>
<th>Time for weeding 8 mt (second)</th>
<th>Speed m/sec km/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>0.348 1.25</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>0.333 1.20</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>0.333 1.20</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>0.267 0.96</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>0.286 1.03</td>
</tr>
<tr>
<td>6</td>
<td>26</td>
<td>0.308 1.11</td>
</tr>
<tr>
<td>7</td>
<td>27</td>
<td>0.296 1.07</td>
</tr>
<tr>
<td>8</td>
<td>22</td>
<td>0.364 1.31</td>
</tr>
<tr>
<td>9</td>
<td>28</td>
<td>0.286 1.03</td>
</tr>
<tr>
<td>10</td>
<td>21</td>
<td>0.381 1.37</td>
</tr>
<tr>
<td>11</td>
<td>25</td>
<td>0.320 1.15</td>
</tr>
<tr>
<td>12</td>
<td>35</td>
<td>0.229 0.82</td>
</tr>
<tr>
<td>13</td>
<td>29</td>
<td>0.276 0.99</td>
</tr>
<tr>
<td>14</td>
<td>26</td>
<td>0.308 1.11</td>
</tr>
<tr>
<td>15</td>
<td>25</td>
<td>0.320 1.15</td>
</tr>
<tr>
<td>16</td>
<td>23</td>
<td>0.348 1.25</td>
</tr>
<tr>
<td>17</td>
<td>20</td>
<td>0.400 1.44</td>
</tr>
<tr>
<td>Mean</td>
<td>25.65</td>
<td>0.32 1.14</td>
</tr>
<tr>
<td>Std</td>
<td>3.580</td>
<td>0.042 0.15</td>
</tr>
</tbody>
</table>

**Table 5. Field test capacity of prototype upland weeder**

<table>
<thead>
<tr>
<th>Size of land</th>
<th>1st operator</th>
<th>2nd operator</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (mt)</td>
<td>4.9</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Length (mt)</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Area (mt²)</td>
<td>39.2</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Time (min)</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Capacity (mt²/mnt)</td>
<td>3.56</td>
<td>2.91</td>
<td>3.24</td>
</tr>
<tr>
<td>Capacity (mt²/hour)</td>
<td>213.82</td>
<td>174.55</td>
<td>194.18 97.091</td>
</tr>
<tr>
<td>Capacity (hour/ha)</td>
<td>46.769</td>
<td>57.292</td>
<td>52.03 104.06</td>
</tr>
</tbody>
</table>

**Table 6. Field test capacity weeding upland paddy by angady (Madagascar hoe tool)**

| Area (mt²) | 72 |
| Length (mt) | 8 |
| Width (mt) | 9 |
| Number of plot | 3 |
| Total area (mt²) | 216 |
| The number of worker | 2 |
| Duration of work (hour) | 6 |
| Total man hours (man h) | 12 |
| Capacity 1 operator (hour/ha) | 555.56 |
The calculation of cost for weeding by angady and prototype upland weeder are quite significant difference. Weeding by angady took 92.6 man-days per ha, by assumed work time per day 6 hours and labor cost per person per day 5000 Ar, therefore total cost per ha equal 463,000 Ar per ha. Meanwhile by using prototype of upland weeder need worker 17.4 man-days per ha, by same assumed of work time per day and labor cost per person, the total cost per ha only 87,000 Ar per ha.

Figure 14. Photo filed test prototype of upland weeder

3.3.3. Performance Low cost cycling pedal thrasher

The last prototype that developed by TCE was not a major task as mention on TOR, but in view of TCE this machine was very important step to help the farmer for threshing the paddy and the advantage as national policy of Madagascar country need to reduce losses of paddy during harvest. TCE has new idea for introduce new system of harvest paddy which by threshing paddy on the field just soon after cutting, by it the quality of grain become increase and losses by scatter during transport grain together straw could be reduce. Some of paddy field in Vakinankaratra, Bongolava, Itasy and Analamanga are located on remove and hilly area therefore there are not enough fram road to bring big machine until close to the paddy field. The prototype cycling pedal thrasher is very light only 23 kg, therefore could bring by 1 person. Furthermore this prototype can be as an alternative for solve and help the farmer for threshing the paddy. More ever the price of it also equal to the price of price of one bicycle as the common transportation tool in Madagascar.
The performance and result test of prototype pedal thresher shown as table below

Table 7. The capacity and threshing efficiency of prototype cycling pedal thresher

Test date : 21 March 2012, Vinankarena Vakinankaratra, Madagsacar
Variety of paddy FOFIFA 161

<table>
<thead>
<tr>
<th>No</th>
<th>No of bundle</th>
<th>Weight of paddy plus straw (kg)</th>
<th>Grain (kg)</th>
<th>Straw (kg)</th>
<th>Threshing eff (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>9.22</td>
<td>310</td>
<td>0.08969</td>
<td>0.239 99.76</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>9.22</td>
<td>294</td>
<td>0.07712</td>
<td>0.226 99.77</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>9.22</td>
<td>287</td>
<td>0.09100</td>
<td>0.221 99.78</td>
</tr>
</tbody>
</table>

Performance of prototype cycling pedal thresher also done by durability test on the farmer Sahalambo Antsirabe Vakinankanatra, which operated on harvest season during 4 weeks. The were some comment from the operator, the functional of all components was quite good, but on the transmission part which use chain of bicycle need pay attention specially the tightening should be done frequently by moving position of drum to forward.
Otherwise if operated do not pay attention about it the chain will loss or may be become easy to be cut or worn out.

Figure 15. Photo of testing and operating prototype low cost pedal thresher

3.4. Transferring technologies

Transferring technologies was very important as for indicator successfully of introducing new technologies. That also can be said after designing and developing the next step is introducing and disseminating the technology. The method for succeeding technology of appropriate farm machinery is by transferring the knowledge and skill which consist of how to produce, how to use and how to maintain the prototype. Therefore hopefully the technology will be sustain on the future. For the 3 kinds of new prototype which developed by TCE in CFAMA, firstly TCE introduced it to the potential user who are farmers. To do conduct this activity TCE helped by DRDR Vakinankaratra as agent of change for the farmer culture belong to Ministry Apiculture of Madagsacar. The activity of introducing technology appropriate technology farm machinery has the title “Appreciation of Utilization on Seeder and Weeder for upland paddy” it was done on 12 April 2012 in CFAMA. The activity has several objective such as
-To introduce new prototype new prototype “**Rolling Injection Seeder**” and “**Weeder**” for upland paddy to the farmer.

- To conduct practicing operated new prototype “**Rolling Injection Seeder**” and “**Weeder**” for upland paddy on the field together with farmer.

- To get feed about introducing the two new prototypes by discussing among farmer.

The activity was attended by farmer which come from surrounding Vakinankaratra Region and also accompanied by CDR from some district. The paprizs member Vakinankaratra were also joint on this occasion. The number of farmers are 14 people. From this introducing activity could be get some information and impression and also feedback for improving the prototype in side of developing step. Another advantage is to know how the farmer will accepted the prototype.

![Figure 16. Photo during introducing technology by practicing trial new prototype rolling injection seeder on the field.](image)
The next forward step of transfer technology is by conduct “training trial making of the new appropriate prototype farm machinery”. The targeted subject of this activity is the local artisan where stay nearby farmer as target consumer or users. The roles of artisans are very important to make the success of disseminating and vulgarization of prototype. The farmers are needed trust and also cooperation with local artisan who stay surrounding them. Therefore transfers knowledge and skill related to the how to produce the prototype which started from selecting material, measuring, cutting, joining and others process to construct the prototype until finish should be done perfectly and completely. The method to conduct this activity is done by providing technical drawing which is consist 2 dimensional, 3 dimensional, and also isometric drawing that all is done by AutoCAD. The process of training starting by give explanation general feature of prototype will be produce, continued by give explanation detail drawing. After that the artisan accompanied by TCE and many CFAMA technician also some C/P of TCE and assistant of TCE together produce the prototype part by part. By this practicing trial making TCE also could transfers the knowledge of developing and manufacturing prototype to the all stake holder consist C/P, local artisan, CFAMA and also DRDR staff who has responsibility to disseminating the technology.

The first trial making training was done on 24 – 28 April 2012, attended by artisan from Analamanga and Itasy region which is total number of artisans are 15 people. The are practice to manufacture single row rotary weeder as the result they could finished 3 units prototype rotary weeder for wet land paddy. Unfortunately they could not test their product due to unavailability of proper young paddy to be cultivated. But all participant are ready and capable to produce it and they will try to produce it because TCE give to them some row material as critical part of rotary weeder.

The second trial making training was done on 8 – 12 may 2012, the artisans are come from Vakinankaratra and Bongolava region by the total number of artisans 8 people. The objective was to manufacture three kind of new prototype (1). Prototype upland weeder (2) Prototype Low cost cycling pedal thresher (3) Prototype New Rolling Injection seeder. As the targeted, finally the can produce 3 units of prototype by one unit of each prototype. Due
to the proper time of harvest season of paddy all of members participant could test low cost cycling pedal thresher. For testing rolling injection seeder and weeder prototype CFAMA provide the land to be use it.

Table 8. Schedule of training trail making rotary weeder for artisan Itasy and Analamanga region

<table>
<thead>
<tr>
<th>DATE</th>
<th>HEURE</th>
<th>CONTENU</th>
<th>LIEU</th>
<th>ENCADREUR</th>
</tr>
</thead>
</table>
| 24 Avril 2012| 8 h - 10 h | - Ouverture officielle de la formation  
- Présentation des participants  
- Prévention des accidents | Amphithéatre | DRDR  
- CFAMA  
- Expert JICA  
- TCE Assistant |
|              | 10 h - 10 h 15 | PAUSE CAFE |           | Expert JICA  
- TCE Assistant |
|              | 10 h 15 - 12 h |   - Projection dessin technique  
- Sous ensemble  
- Ensemble |          | CFAMA  
- Expert JICA  
- TCE Assistant |
|              | 12 h | DEJEUNER |           |                   |
|              | 13 h 30 - 17 h | - Répartition en 3 groupes  
- Débitage/Etoile doigts (TPN 15/10)  
- Débitage  | Atelier | CFAMA  
- Expert JICA  
- TCE Assistant |
|              | 8 h - 10 h | - Technique d’assemblage  
- Soudage |          | CFAMA  
- Expert JICA  
- TCE Assistant |
| 25 Avril 2012| 10 h - 10 h 15 | PAUSE CAFE |           | Expert JICA  
- TCE Assistant  
- CFAMA |
|              | 10 h 15 - 12 h | - Débitage des matières premières | Atelier | CFAMA  
- Expert JICA  
- TCE Assistant |
|              | 12 h | DEJEUNER |           |                   |
|              | 14 h - 17 h | - Etude comparative des différentes sarcelles | Atelier | Expert JICA  
- TCE Assistant  
- CFAMA |
|              | 8 h - 10 h | - Finition des 3 sarcelles  
- Débitage des matières premières | Atelier | CFAMA  
- Expert JICA  
- TCE Assistant |
| 26 Avril 2012| 10 h 15 - 12 h | - Débitage des matières premières :  
Fer plat 30 x 2  
TPN 15/10  
Tube 12/17 et 20/27 | Atelier | Expert JICA  
- TCE Assistant  
- CFAMA |
|              | 12 h | DEJEUNER |           |                   |
|              | 13 h 30 - 16 h | - Analyse de fabrication des différentes sarcelles | Salle d’étude | Expert JICA  
- TCE Assistant  
- CFAMA |
|              | 16 h 25 - 17 h 30 | - Remise des certificats  
- Fermeture officielle de la formation | Réfectoire | DRDR  
- CFAMA  
- Expert JICA  
- TCE Assistant |
Table 9. Schedule of training trail making Upland weeder, Low cost pedal thresher, rolling injection seeder for upland paddy for artisan Vakinankaratra and Analamanga region

<table>
<thead>
<tr>
<th>Hour</th>
<th>Tuesday 8 May 12</th>
<th>Wednesday 9 May 12</th>
<th>Thursday 10 May 12</th>
<th>Friday 11 May 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>08h00 – 09h00</td>
<td>– Opening</td>
<td>– Introduction of participants</td>
<td>– Explanation of PAPRiz project target and of the training target</td>
<td>Practices</td>
</tr>
<tr>
<td>09h00 – 10h00</td>
<td>Introduction of farm mechanization (Generality)</td>
<td>Practices</td>
<td>Practices</td>
<td>Practices</td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10h15 – 11h00</td>
<td>Explanation of technical drawing</td>
<td>Practices</td>
<td>Practices</td>
<td>Practices</td>
</tr>
<tr>
<td>11h00 – 12h00</td>
<td>Explanation of technical drawing</td>
<td>Practices</td>
<td>Practices</td>
<td>Practices</td>
</tr>
<tr>
<td>Lunch 1</td>
<td>Theories</td>
<td>theories</td>
<td>Theory</td>
<td>Final evaluation of the training</td>
</tr>
<tr>
<td>3h30 – 14h00</td>
<td></td>
<td></td>
<td></td>
<td>Question – Answer</td>
</tr>
<tr>
<td>14h00 – 15h00</td>
<td>theories</td>
<td>theories</td>
<td>Practices</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>15h15 – 16h00</td>
<td>Practices</td>
<td>Practices</td>
<td>Practices</td>
<td>Certification</td>
</tr>
<tr>
<td>16h00 – 17h00</td>
<td>Practices</td>
<td>Practices</td>
<td>Practices</td>
<td>Closing</td>
</tr>
</tbody>
</table>

Legend:

- Training about Upland weeder
- Training about Low cost Pedal thresher
- Training about Upland seeder
Figure 17. Photo artisan from Itasy and Analamga on training trial making prototype in CFAMA.

Figure 18. Photo artisan Vakinankaratra and Bongolava on trial making prototype in CFAMA
Figure 19. Photo artisan from vakinankaratra and Bongolova conduct testing of their product after trial making

The other method of transferring technology is by conduct demonstration on some places who targeted consumer they available. TCE try to conduct demonstration of the previous prototype which already develop and introduced 2 years ago but still need more actions of field to speed up vulgarization and dissemination of technology. The prototype winnower wood type is the prototype that try to be disseminated y this method. By coordination DRDR Vakinankaratra, CDR Betafo, head of commune Betafo and also together with the role active of one artisan in Betafo who on 2011 was already trained to produce it in CFAMA the activity could be running well. On the date C/P and some CFAMA engineer give explanation to the visitor on the middle of Betafo market. The explanation manly about the function of the machine, how to operate, capacity and also where the visitor could be get this produce in they want own it. All information’s are had been written in brochure which also distributed freely to the visitor.
IV. FACTOR THAT HAVE PROMOTED THE PROJECT

4.1. Impact

Some factor that have promoting and supporting the activity done by TCE, the main was supporting facilities by CFAMA during developing of prototype farm machinery. Cooperation from all CFAMA member start from Director, two C/P and some technicians CFAMA workshop. Others factor also very significant effect for running to the several kind activity done by TCE was also good coordination and directing by Papriz project also supporting budget from JICA Antananarivo. DRDR Vakinankaratra was also very important agent as key of succession activity of TCE, by putting the coordinator Papriz on each region also make the activity better than 2 years ago when there was not yet establish it. The farmer and artisan as both later on become consumer and producer farm machinery, both of them actually well welcome to the any technology of farm machinery especially the simple and appropriate one.
4.2. Sustainability

To do several activities related design and developing appropriate farm machinery need cooperation and coordination with all stake holder both from project side member and Madagascar side. The environment and electric supporting facilities by national electric company (JIRAMA) also quit enough factor to support running well project activity. The active participative from all technicians and some local artisan during following workshop also very important factor for succession the project. For the next step after developing and disseminating some prototype of farm machinery the all stake holder consist Papriz, CFAMA, DRDR and Min Agri Madagascar should try to make extra ordinary effort on the farmer side by give some bit allowance to the farmer who want awn the appropriate farm machinery. Of course such kind activity should done by make some criteria and carefully. The Madagascar farmers need to be change and increase not only their knowledge and skill but also the culture and minded from traditional thinking or subsistent system agriculture to the one step further little bit thinking about business oriented, so therefore they their welfare become improve future.

V. CONCLUSIONS

On the second period, TCE to be assign in Madagascar have been started since Dec 2011 ~ June 2012. The activity, which is coverage many activity start collected information, improvement and development appropriate farm machineries and introduced it. Finally, there are several conclusion could be as follow:

- By supporting all stake holder TCE could design, manufacture 3 kinds of new prototype. It is comprises five (5) units prototype single row manual upland weeder, six (6) units prototypes low cost cycling pedal thresher and three (3) units prototype new rolling injection seeder for upland paddy. One of them already tested on the farmer side or called durability test which is cycling pedal thresher and the result quit perfect.
- The TCE also conduct activity “one day appreciation of utilization those new prototype on limited farmers Vakinankaratra region” before disseminating to the big scale farmer. By this activity TCE could receive first impression and also receive some
feedback comment from new potential farmer consumer. It was done at first April 2012 at CFAMA Antsirabe Vakinankartra.

- Further activity related to the testing on the field also done in surrounding CFAMA Antsirabe together with the farmer. As the result some modification was done in CFAMA workshop. Even some of the prototype was could not tested perfectly and thoroughly due to improper weather and season but generally the result was quit perfect.

- Transferring technology to the artisan as the potential producer on the future was done 2 times. Firstly, Conduct training trial making manufacturing rotary weeder of wet land paddy to the artisan from Analamanga and Itasy Region. Secondly, Conduct training trial making manufacturing Up land weeder, cycling pedal thresher, rolling injection seeder for artisan Vakinankaratra and Bongolava Region.

- Another activity done by TCE is make dissemination and demonstration and also join on some expo of farm machinery. Dissemination of winnower machine directly on open market at Betafo Vakinankaratra region was very challenging activity. The more existing and enjoying activity was join on expo Papriz activity at Amabantondrazaka Alaotra Mangoro region together with some popular Madagascar actor and actress, in view of TCE this activity as can be alternative to speed up disseminating of the technology and new prototype. Hopefully its would be easy to be know by farmer and all stake holder who interest to utilize it.

VI. RECOMMENDATIONS

6.1. To the Ministry of Agriculture

Related to succession farm machinery sector since prototype until dissemination to real costumer farmer, the Ministry Agriculture should be give more attention to this sector and collaboration with Ministry of Industry. For more real action to promoting farm machinery sector, strengthening of CFAMA is very important first TCE suggested to do regeneration of human resources especially on designing, developing, testing, disseminating and monitoring division. To speed up disseminating some prototyping CFAMA by supporting MINAGRI should give more attention to local artisan which available from all Madagascar area by given new information technologies related farm machinery, increase
knowledge of them through several training both in CFAMA or on the job training on some industrial company. On the MinAGRI there is Direction du Genie Rural in view if TCE this directorate should be more active to make action for promoting appropriate farm machinery together with CFAMA as technical institute such as conduct standard national of Madagascar about utilization of farm machinery. For the recently deal with promoting of utilization of pedal thresher for threshing the paddy as the one important step for reducing losses of paddy during harvest, for the beginning Directorate du Genie Rural could make survey about losing of grain threshing by several type of tool included beating system mostly done by farmer. Later on by those datum Min Agri could make justification and action by introducing pdal thresher to big scale of paddy area in Madagascar and hopefully by reducing percentage number of losses the total production of national rice in Madagascar will be increase.

6.2. To JICA

Concerning about promoting farm machinery to support agriculture sector in Madagascar to get final goal to increase capacity, efficiency and to reduce time work, losing yield in the field, for next several next year this sector still need pay attention start form developing, dissemination, monitoring and evaluation. By PAPRIZ project continuing activity on farm machinery sector should be following by several activity such as on job training on local artisan to introduce new prototype, undertake field test of new and promoting farm machinery on several region and places with farmer and get some comment and impression about new promoting prototype. On the next soon sowing season of upland paddy that may be start on October, Papriz project should prepare technology prototype seeder for up land paddy which was already development by TCE but still needed more activity to make durability test or even to conduct more training trial making about upland seeder and rolling injection seeder just for specific artisan. And also regarding planning of central Papriz project to try technology semi direct paddy on some Ambantondrazaka need special preparation to the prototype Rolling injection seeder may be need some bit modification about it.
VII. FEASIBILITY FOR THE NEXT PROGRAM

- About dispatch plan of the next coming June – Dec 2012 TCE on appropriate farm machinery sector which already scheduled by Jica. TCE has opinion same as principal of Papriz, which more focus on activity to reduce losses of paddy during harvest start cutting until milling process. The other activity is also should be focus on increasing milling quality of paddy, many activity such as developing appropriate simple tool or machine in side milling configuration could be done.

- Dispatch plan of TCE on domain of Appropriate Agricultural Machinery that most of time stay on CFAMA schedule could be modified. TCE has opinion for the new engineer as TCE would be assign in Madagascar working together with papriz will get difficulties, therefore overlapping time is needed around 3-4 weeks.

- For supporting activity of TCE which mainly stay in CFAMA Antsirabe, the composition of counterpart from Madagascar side could be modified, especially TCE who belong to finalization stage it needed counterpart who know better about field condition and farmer, therefore composition of counterpart one of them could be come from DRDR Vakinankaratra which also work nearby TCE on Antsirabe

- For supporting activity the next TCE of farm machinery is is better if papriz could provide one portable computer for assistant TCE, which is need portable computer with the high enough RAM memory to help TCE for drawing and designing farm machinery on daily work in CFAMA.
Annex 1. PAPRIZ project summary

**Project for Rice Productivity Improvement in Central Highland in Madagascar (PAPRiz)**

**Alaotra-Mangoro**
1. Model Site: PC 23 (45km from Ambatondrazaka)
2. Rice culture: Irrigated cultivation
3. C/P: DRDR, FOFIFA, CMS
4. Altitude: 770m

**Bongolava**
1. Model Site: Périmètre of Ankompomboay (30km from Tsiranoanomandidy)
2. Rice culture: Irrigated rice, Rain-fed cultivation
3. C/P: DRDR, FOFIFA, CMS
4. Altitude: 830m

**Vakinankaratra**
1. Model Site: Périmètre of Andrina Sahalombe (2.5km from Antsirabe)
2. Rice culture: Irrigated cultivation, Rain-fed cultivation
3. C/P: DRDR, FOFIFA, CFAMA
4. Altitude: 1300m

**Project summary**

**Overall Goals:**
Rice production in central highland is increased.

**Project's Purpose:**
Productivity of rice increases in the model sites.

**Duration:**
JFY 2008 to 2013 (5 years)

**Target Area:**
Five Regions in Central Highland (Alaotra-Mangoro, Bongolava, and Vakinankaratra as focal Regions, and Analamanga and Itasy)

**Outputs:**
1. Integrated technical packages for rice productivity improvement are developed through the Project,
2. Seed multiplication and distribution systems are promoted under the Project,
3. Linkage among stakeholders in the focal Regions is strengthened,
4. Technical instruction materials are created for disseminating integrated technical packages.
Annex 2. TOR of Appropriate farm machinery on Dec 2011 – June 2012 on frame work PAPRIZ project

TOR of TCE (Nov 2011 – May 2012)
1. Improvement of seeder and weeder for upland rice
   a) improve the developed equipment (seeder and weeder for upland rice) based on the field test with farmers,
   b) train local manufacturers about manufacturing appropriate machinery in three focal regions,
   c) recommend the Project for a strategy and possible actions to promote local machinery production
2. Field test and data collection of developed machines
   a) undertake improvement and engineering performance test of machines/tools developed by previous TCEs
   b) undertake field test and data collection for developed machines/tools with farmers and local manufacturers
3. Collect information
   a) collect information on existing machines/tools,
   b) assess needs of farmers in three focal regions,
   c) evaluate potential of mechanization of farming operations,
   d) identify types and specifications of machines/tools to meet their needs,
   e) Provide technical support on appropriate machinery use for DRDR (regional stations of MinAgri) staff and extension agents
Annex 3. Documentation of Developing, Manufacturing, Introducing, Disseminating of prototype farm machinery in Madagascar

1. Designing and manufacturing upland weeder

2 Design and manufacturing low cost cycling pedal thresher

3. Design and manufacturing rolling injection seeder
4. Introducing technology of new prototype

5. Testing cycling pedal thresher on farmer site
6. Conduct expo farm machinery together Papriz expo on Ambatondrazaka