Republic of Mozambique
Ministry of Agriculture
National Directorate of Agricultural Extension

MANUAL ON RICE CULTIVATION

PROMPAC

The project for Rice Productivity Improvement in Chokwe Irrigation Scheme

Japan International Cooperation Agency (JICA)

August 2014

- First Edition -

Preface

This manual has been prepared based on a project implementation in Chokwe irrigation scheme in Gaza province. The project for “Rice Productivity Improvement in Chokwe Irrigation Scheme (PROMPAC)” has been implemented from February 2011 to October 2014 as project phase 2 after the project phase 1 named “Integrated Agricultural Development Project for Small Scale Farmers in Chokwe Irrigation Scheme” from 2007 to 2010.

The improved techniques are developed through experiments and verifications at project sites in Chokwe irrigation scheme by considering their environment and economical conditions. Therefore the techniques are very much suitable for Chokwe farmers and the difference from Chokwe should be considered if you would like to disseminate it to other areas. The significant differences of improved techniques from conventional techniques are (1) Spacing of transplanting method, (2) Water management techniques in the first 30 days of direct sowing techniques and (3) Fertilizer application methods in rice cultivation techniques. The farmers’ group management including revolving fund activities and participatory water management and maintenance of irrigation facilities by farmers are included in this manual to develop integrated rice cultivation in Chokwe irrigation scheme.

This manual is developed for extension agents, researchers and advanced farmers. Furthermore, more detail information is available in project progress report and work completion report, and also the poster material is available for more concrete information. We hope this manual helps you to understand the techniques and promote better rice cultivation.

Mr. Kiyoshi Masubuchi
Chief advisor of PROMPAC
August 2014

Acknowledgement

I would like to express our special thanks of gratitude to JICA and DNEA, Ministry of Agriculture as well as DPA Gaza who gave us the opportunity to execute this project, which also helped us in doing experiment of techniques and we received so many information about new techniques and experiences. Secondly I would also like to thank farmers and extension agents who helped a lot in investigation and actual implementation within the limited time. Thank you again to all who helped us to implement the project and create this manual.

Mr. Inacio Mateus Mugabe
Director of SDAE Chokwe / Project manager of PROMPAC
August, 2014

Messages

The cooperation in the Chokwe Irrigation Scheme between two countries through JICA and MINAG for almost a decade has brought the development and improvement techniques for irrigated rice cultivation among the specialists, community people and related organizations for increasing rice production and productivity.

This manual is prepared and edited covering the techniques of broader areas related to rice cultivation with both methodologies of transplanting and direct-seeding. Although we JICA are planning to provide all necessary support in developing new project in the area of rice cultivation, we hope that the knowledge gained from this project will continue to expand for more people and to whole Gaza province and Mozambique in a sustainable manner.

We appreciate a lot for the cooperation provided by the Mozambican counterpart and we hope that a continuous and lasting harmonious relationship between two countries will contribute to the poverty reduction for the benefit of the people of Mozambique.

Mr. Katsuyoshi SUDO
Representante residente de JICA Mozambique office
August 2014

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CHAPTER 1

Rice Cultivation Techniques

1. Rice Cultivation in Chokwe

1.1. Rice Production in Mozambique and Chokwe

In the past five years in Mozambique the area planted to rice was 170,000 ha/year and production was 120,000 t/yr (average yield of paddy is 0.8-1.6 t/ha). With the increase in demand for rice (25 kg/capita/year) the rice self sufficiency percentage dropped drastically (24.7% in 2004) and more than 300,000 tons of rice was imported to compensate. Rice is the second staple food next to maize. From the food security standpoint, self-sufficiency should be achieved immediately.

The Chokwe Irrigation Scheme (CIS), situated along the Limpopo River in Chokwe District, Gaza Province, is the largest irrigation scheme in the country. Irrigated area is 26,000 ha. The CIS used to be the country's granary, which at its highest capacity; it produced more than 50,000 tons of rice. Today, rice production in the CIS is only about one tenth of the above mentioned production due to many factors: civil war in the 80's, change of the economic system after independence, and the flood of the Limpopo River in year 2000. The change of cultivation area of major crops in CIS from 2001 to 2007 is shown in figure1.1.

Soil and weather conditions of the region causes difficulties for the establishment of dry field direct sowing rice cultivation in Chokwe irrigation scheme. The soil condition of the project area is characterized by small soil particles of alluvial soil from Limpopo River and special irrigation method "bleeding irrigation" is indispensable in order to ensure a safe germination and seedling establishment. The improvement of irrigation will not be enough to ensure seedling establishment and improvement of land preparation, field layout, sowing method and bird scaring are required.

Weather condition and high solar radiation in Chokwe are favorable factors for high production of rice once improved cultivation techniques are introduced. However, the average yield of transplanting rice cultivation ranges from 3 to 4 t/ha and that of direct sowing is around 2 to 3 t/ha. In upper stream of Chokwe irrigation scheme, transplanting is widely practiced and direct sowing in the middle and lower stream.

Technical components of traditional transplanting are; transplanting old aged single seedling per hill, no fertilizer application, no weeding and harvesting at over matured stage which are main causes of low productivity.

In case of direct sowing cultivation, broadcasting is commonly practiced and poor germination and poor seedling establishment cause low production of panicle per unit area. Poor germination and poor seedling establishment are mainly because of soil condition, alluvial soil of Limpopo River, land preparation of paddy field, seed sowing method and irrigation after sowing seed.

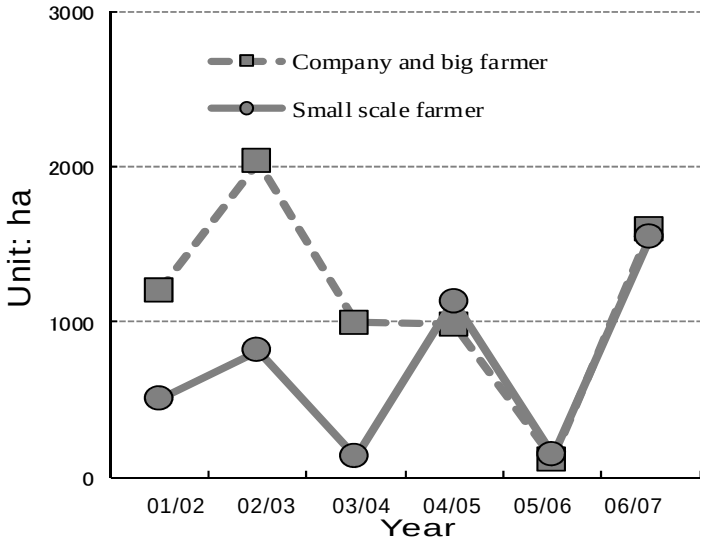


Figure 1.1: Rive cultivation in Chokwe irrigation scheme 2001/02 to 2006/07.
Source: SDAE, Chokwe District, Extension Department.

1.2. Weather conditions and suitable season for rice cultivation in Chokwe

The weather conditions of Chokwe are extremely excellent for paddy cultivation compared with those in Asian countries. The dominant position point of weather in rice cultivation season is: very abundant amount of solar-radiation; big daily temperature range; small precipitation; low relative humidity through the whole growth period.

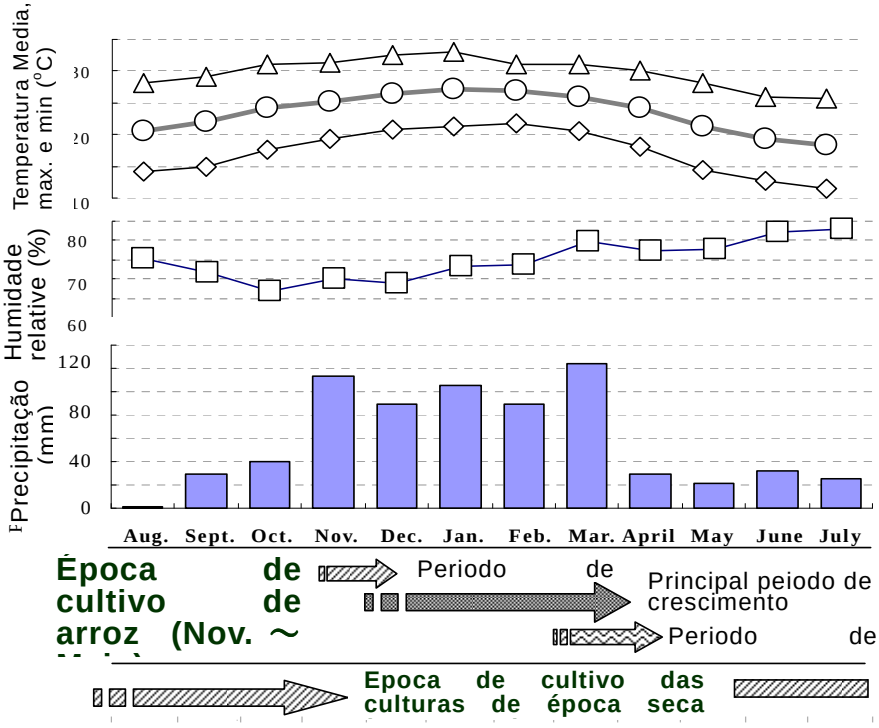


Figure 1.2: Weather conditions (1997/2006) and crop cultivation in Chokwe
Source: Chokwe Agricultural Experimental Station

1.3. Traditional rice cultivation techniques of Chokwe irrigation scheme

1.3.1. Rice production of small scale farmer

Results of the survey on rice production of transplanting cultivation indicates that company/contact farmer and research station obtain 4.7 and 4.9 t/ha of grain yield respectively, but small scale farmer can produce only 3.4 t/ha. The biggest cause of low yield in farmers' field is small panicle number per unit area and low spikelet number per panicle. On the other hand, there is no big difference in filled spikelet percentage and weight of 1,000 grains between small scale farmers and company/contact farmers and research station.

Respect to direct sowing rice cultivation, the average yield of farmers was 2.9 t/ha while yield obtained in EAC experimental field was 4.7 t/ha. Analysis of yield components indicates that significant difference of filled spikelet percentage and 1000 grain weight between farmer's traditional technique and improved technique. The causes of low yield of farmer's practice are outbreak of weak tillerings due to delay in nitrogen application, low light receiving intensity due to mutual shading by excessive seed rate (150 kg/ha), delay in nitrogen top dressing and weeding, and poor water management at late growth stage.

1.3.2. Traditional rice cultivation techniques

Traditional farmer's cultivation techniques are not adequate for higher yield production. This is due to the many problems and defects inherent to the current rice cultivation technique. Those problems and defects are summarized as follows;

[Seeds]

- Use of many varietal mixture; no pure seed is used.
- Many weed seeds are mixed with paddy seeds.
- Many empty and imperfectly ripened grains are mixed.

[Seed pre-treatment, Seed bed and nursing of transplanting cultivation]

- No seed pre-treatment, such as seed selection, soaking and incubation, is carried out.
- Absence of sufficient seed bed area for healthy seedling nursing.
- Nursery bed style is not suitable for bringing up quality seedlings.
- Nursery period is too long.
- Many weeds in the seed bed.
- Germination percentage is low due to seeding with dry seed bed style.
- Too much bird attack due to imperfect covering after seed sowing.
- Water management during nursing period is not good.
- Nursery bed preparation is very rough.

[Main paddy field preparation]

Transplanting

- In case previous crops stay in the field, 1st plowing can't start at proper time.
- Plowing by tractor is very sloppy and there remain many un-plowed spots.

- Insufficient weed control due to tillering stage of rice plant.
- Puddling and leveling work are not done.

Direct sowing

Uneven plowing depth (difference reaches up 30cm)

Inadequate soil clos crushing due to uneven plowing depth and crop residue left in the field

Soil movement of field surface

Uneven leveling of field

[Transplanting/sowing]

Transplanting

- Old age seedlings are used.
- Low planting density.
- Single seedling transplanting per hill.
- Deep transplanting (5-7 cm).

Direct sowing

- Mixture of different varieties
- Excessive amount seed (100 to 150kg/ha: 61% of farmer, 150 to 200kg/ha: 36% of farmer)
- Deep placement of seed (more than 5 cm depth) due to uneven plowing by disk plow
- Seed picking by bird (poor coverage of seed)

[Fertilization]

- Most of farmers do not apply any kind of fertilizer.
- Even in case of fertilizer applied, application timing is not appropriate.

[Field management]

- No proper weeding practiced
- Inadequate timing of herbicide application in direct sowing due to poor seedling establishment

[Water control]

- There is no water control in accordance with growth period.
- Inadequate first irrigation after direct sowing causing poor germination due to water standing in the field.

[Harvesting and post-harvest]

- No optimum harvesting time and a lot of harvest losses

1.4. Productivity of varieties widely cultivated in Chokwe

Productivity of three widely cultivated varieties in Chokwe was examined in 2008/09 and the maximum yield obtained was 9.4 t/ha in Limpopo variety, followed by 7.7 t/ha in IR 64 and the lowest yield was 6.8 t/ha in ITA 312. Some new varieties were evaluated in 2013 and 2014 and results obtained are summarized as follow.

Variety	Yield (ton/ha)	Panicle per hill	Spikelet per panicle	Filled spikelet (%)	1000 grain weight (g)	Shattering (%)	Number of days to heading
Alvorada	6.1	17.1	94.6	76.7	25.3	24.6	108
Farox	5.1	14.6	99.9	88.3	25.8	19.6	93
IRGA 409	5.3	14.6	104.9	90.9	23.6	19.4	99
ITA 312	6.3	17.2	100.8	87.8	22.7	21.0	104
Macassane	6.1	14.8	98.4	89.1	28.0	22.1	100
Vembe	2.8	15.4	72.9	78.2	26.6	6.0	73

- No significant difference in yield of five varieties except Vembe
- Alvorada and ITA312 high tillering capacity
- IRGA409 high number of spikelet per panicle and low number in Vembe
- Heavy grain weight in Macassane and Vembe
- High thresh ability in Alvorada and Macassane and low thresh ability in Vembe
- Early maturity in Vembe and about 2 weeks difference among 5 varieties

2. Basic knowledge of grain yield

The paddy yield is constituted by four yield components, namely (a) Panicle number per unit area, (b) Grain number per panicle, (c) Ripening percentage, and (d) 1,000 grains weight as shown below;

To increase the paddy yield, these four yield components need to be “lifted up”; but each component is determined at a different stage/period during the total rice growth stage. On the other hand, some components are influenced by the varietal characteristics strongly, such as 1,000 grains weight and grain number per panicle. The easiest component for effective lifting up” in order to increase yield is the panicle number per unit area. Determination time of each component is shown in figure 1.3.

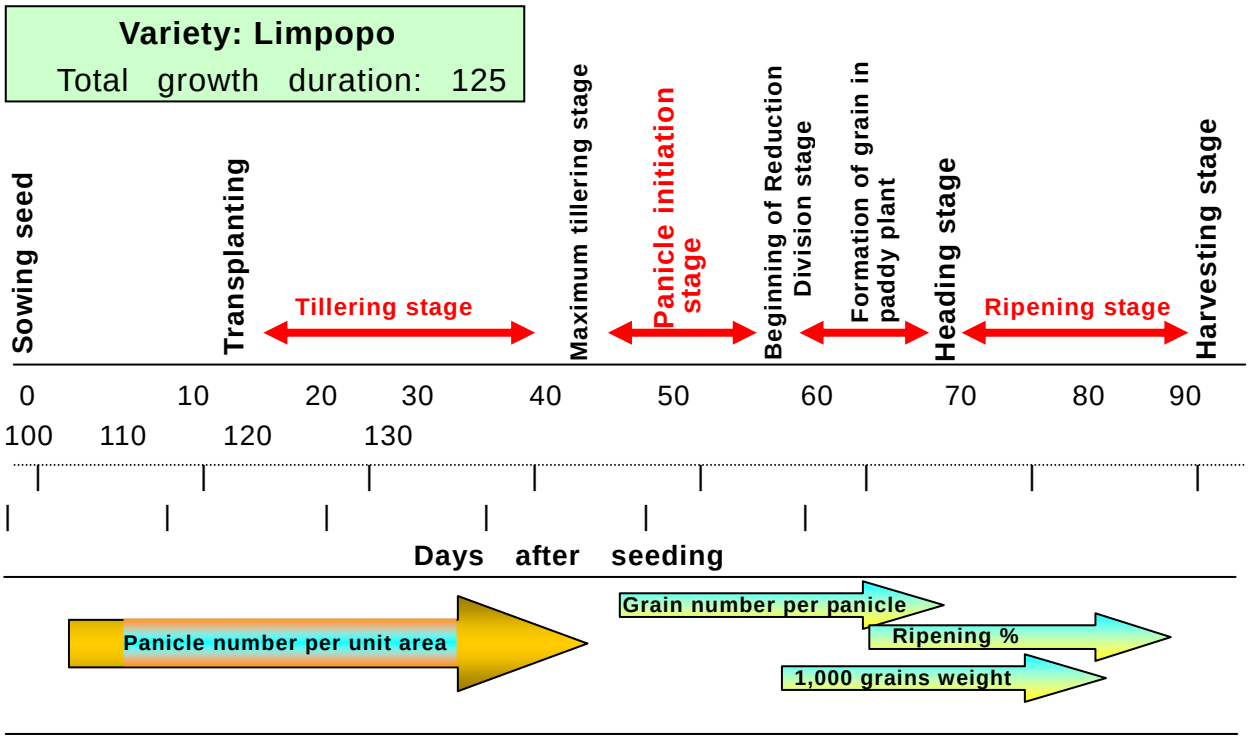


Figure 1.3: Time of determination of each yield component.

3. Rice Cultivation Techniques of transplanting

The most important factors in rice cultivation are a) cultivation season, b) main land preparation, c) nursing healthy seedling, d) transplanting and fertilizer application and e) main field management including water control. It is conceivable that obtaining 10 t/ha paddy yield in farmer's field is not a dream if new cultivation techniques and practices are introduced. Now, let us express the improved technology of rice cultivation in accordance with cultivation order.

3.1. Seed bed preparation method of semi-wet type nursery bed

3.1.1. Seed bed style and preparation method

The raising of seedling is the first step in rice cultivation. Japanese farmer says that the quality of seedlings is generally responsible for 50% of rice yield.

1) Seed bed style

A rectangular shaped and semi-wetted seed bed is recommendable.

According to experiment results, high quality and heavy dry matter seedlings are obtained in a "Semi-wet type seed bed". Heavier seedling will have shorter setting period after transplanting, and more number of tillers during tillering period than seedling from wet and/or dry seed bed.

2) Seed bed area.

A seed bed area of 400 m^2 to 500 m^2 is necessary for each 1 ha of paddy field (The seed bed area includes ditch.)

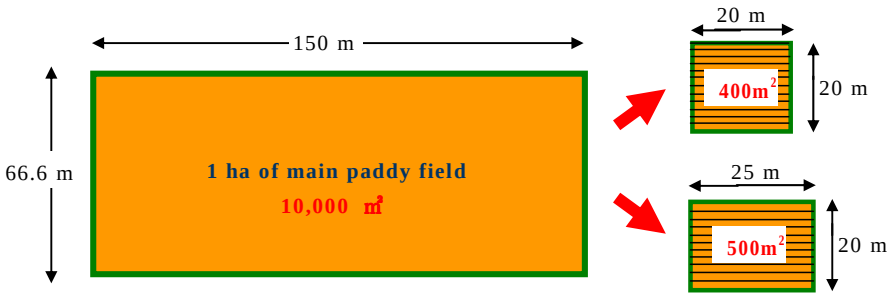


Figure 1.4: Optimum seed bed area per 1ha of main paddy field.

According to experiment results, the seedlings become shorter and smaller if seed bed area narrows to less than 400 m^2 against 1 ha of main paddy field.

3.1.2. Seed requirement and purity

1) Seed requirement for 1 ha of main paddy field.

Seed required for 1 ha of main filed is 55 kg to 60 kg. However, seed requirement vary with germination percentage. If germination percentage is less than 90% add 10% of seed i.e. 80% of germination percentage, seed required for 1 ha will be 60 kg to 65 kg.

2) Seed germination test

Place wet cloth to a shallow and large dish and put 100 selected seed. After placing seed cover seed by wet cloth and wait for 3-4 days. The number of germinated seed is the germination rate. Cloth must be wet during the process of seed germination test.

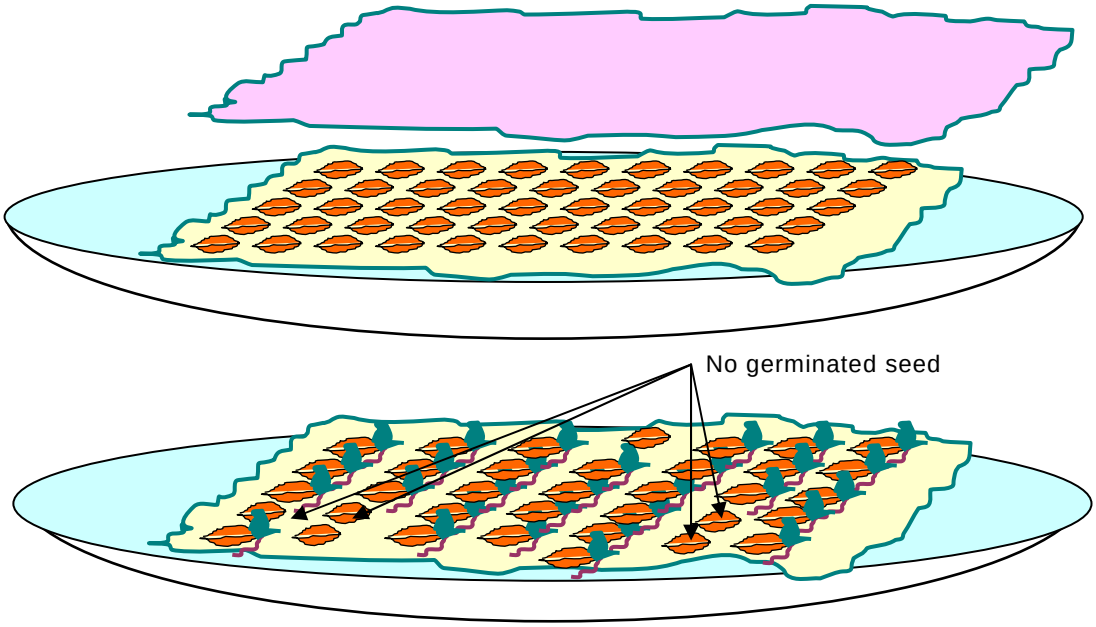


Figure 1.5: Seed germination test

3.1.3. Pre-treatment of seed

The procedure of the seed pre-treatment is as follows:

1) Specific gravity selection.

The specific gravity selection of seed by water must be done before soaking.

The specific gravity selection of seed by water must be done before soaking.

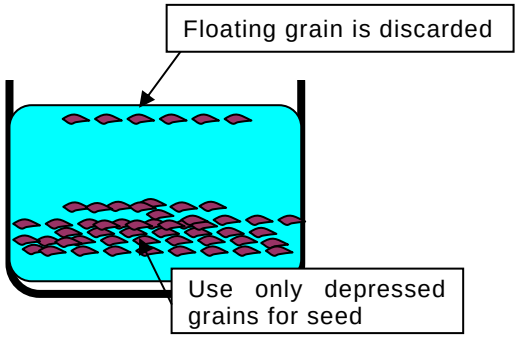


Figure 1.6: Method of specific gravity selections by flash water.

Steps in pre-treatment of seed are;

(1) First of all, prepare bucket, fill it with water.
(2) Put the seed into water.
Fully mature seeds sink and immature or not fully mature seed float.
Use only the soaked grains for seed.
(3) Afterwards these seeds are put into water for about 24-30 hours for sufficient water absorption.
(4) After soaking, take the seed to incubation spot for about 12 to 18 hours. Seed incubation will need careful checking for germination.

2) Seed soaking and incubation.

Soaking the seed into water for about **24-30 hours, and Seed incubation** is about **12-18 hours.** During incubation process there is need for careful checking of the germination condition.

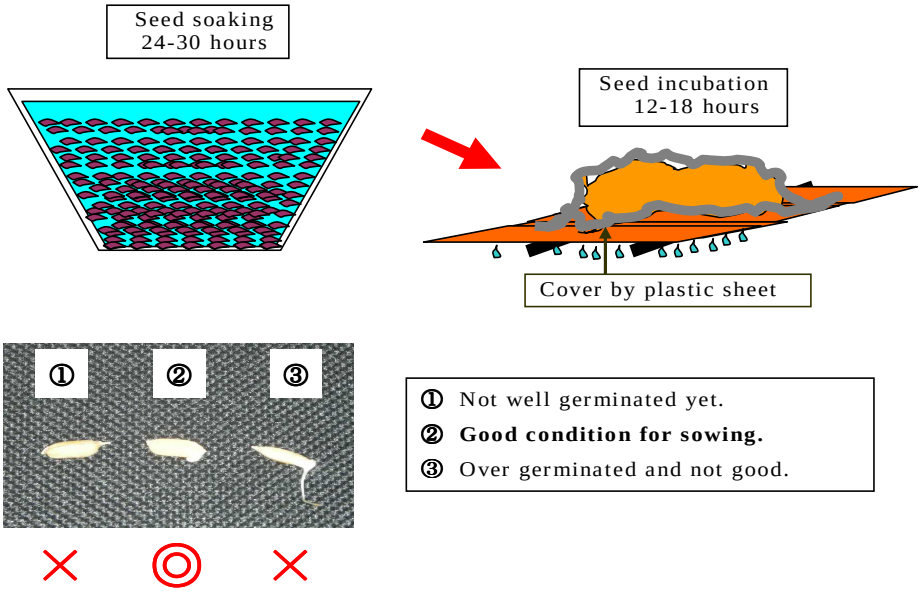


Figure 1.7: Method of seed soaking and incubation, and good germination condition.

3.1.4. Seed bed preparation method and sowing

1) Preparation method of seed bed

Procedure of nursery bed preparation is shown below:

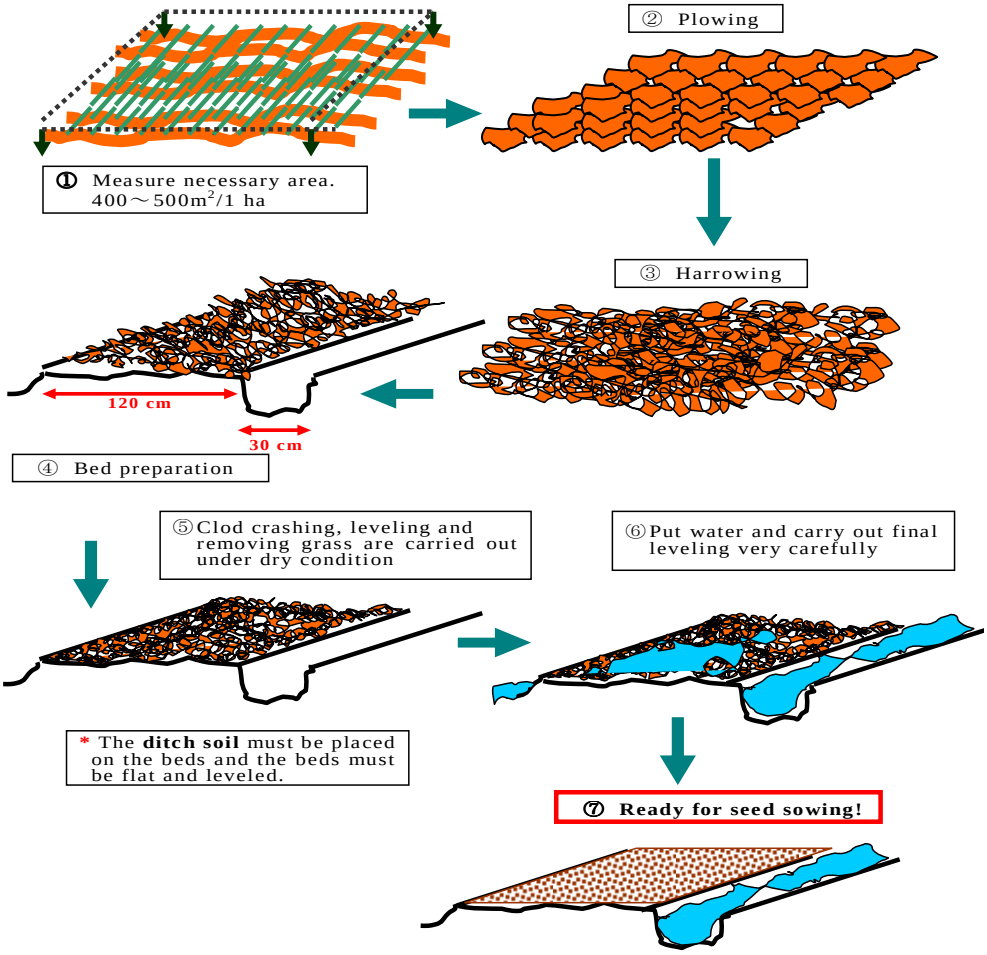


Figure 1.8: Process of seed bed preparation.

Measuring the seed bed area

Making seed bed and ditch

Leveling under dry condition

Final leveling after putting water.

Photos 1.1: Seed bed preparation work

2) Seed sowing

The seed sowing process is shown below;

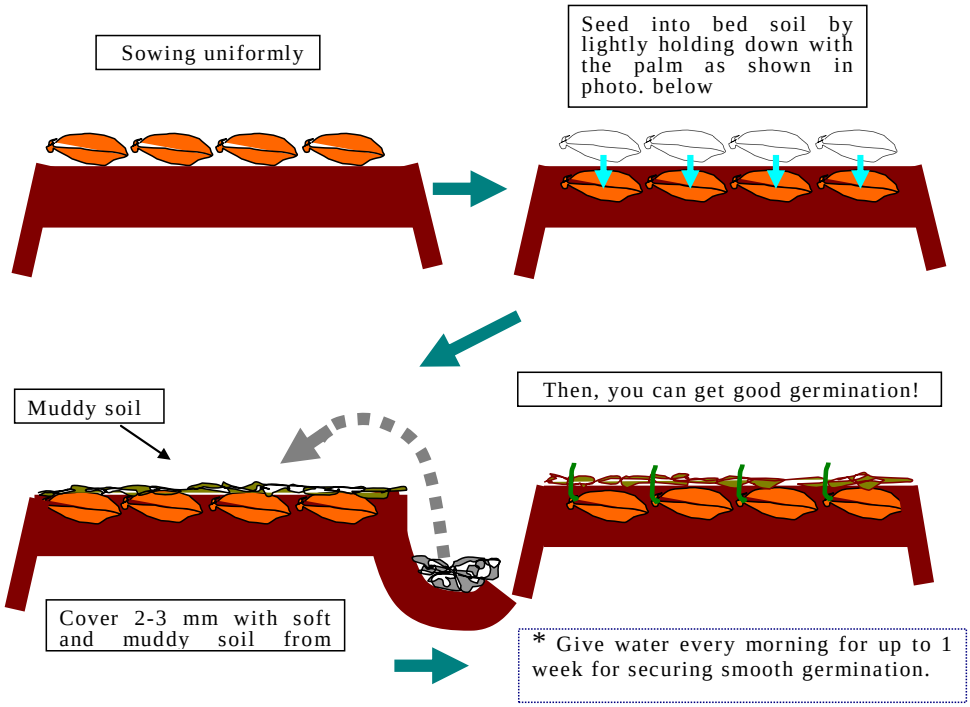


Figure 1.9: Process of sowing seed to nursery bed and covering method

Sowing seed

Tapping and covering work by hand.

Photos 1.2: Seeding and covering work.

3.2. Seed bed preparation method and sowing of dry seed bed style

According to the dry seed bed style method, a large volume of seed (approximately 100kg) are scattered in a relatively small size of field (1/50-1/100 for paddy field). Unfortunately, there is inadequate protective covering for the seeds. This allows for a significant level of seed consumption by birds. The bed preparation is also inadequate. There are many cases where soil clods larger than 10cm diameter still remain in bed at the time of seeding. Under these circumstances, seeds will drop in between such clods and would not be able to germinate. Moreover, a destruction of aggregated structure occurs after the first irrigation as the bed is completely covered with water. The germination rate becomes even lower accordingly. Therefore, the improved semi-dry seed bed style method is suggested along with the semi-irrigated bed method. Here, the size of the paddy is to be 1ha. So the sufficient volume of seed and the appropriate size for the nursery bed are indicated.

3.2.1. Seed bed area, seed requirement and seed selection

Nursery area and seed requirement	
Main paddy field	1 ha (10,000 m^2)
Nursery area	330 to 200 m^2 (1/30 to 1/50 of main field)
Seed rate	60 kg

3.2.2. Seed bed preparation, sowing and irrigation method

1) Measurement for the appropriate size of the bed

The bed area should be measured appropriately and marked using a rope, after the plowing. It is ideal to have the bed area of 1/30 of the paddy, which is 330 m^2, in order to provide an agreeable growing condition.

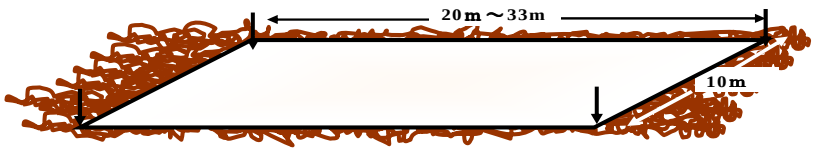


Figure 1.10: Seed bed area

2) Establishment of the outer ridge

The ridge is made by the soil scooped just inside and to outside of the roped boundary. This scooped area will be the furrow and the irrigation canal.

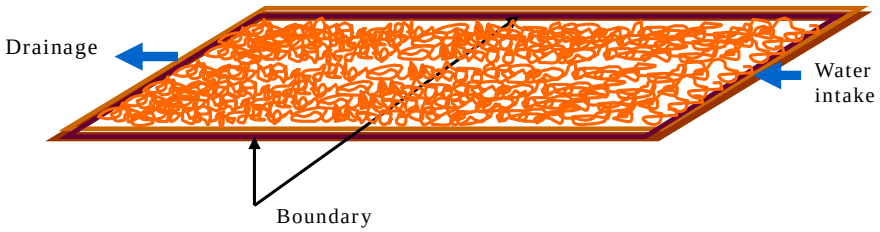


Figure 1.11: Boundary preparation

3) Next, the furrow irrigation as well as drainage canals will be established inside the bed, 30cm wide and 20cm deep at the center.

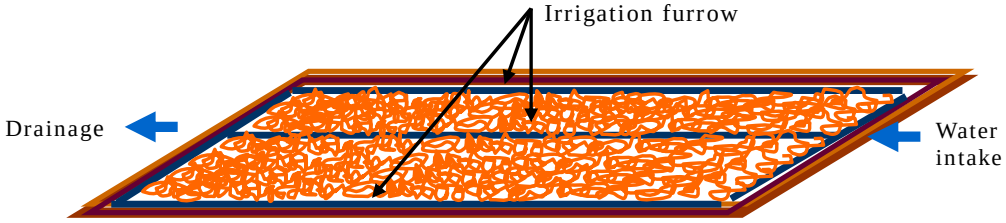


Figure 1.12: Irrigation furrow

4) Clod crushing

Clods of the bed should be crushed as finely as possible and the surface to be leveled.

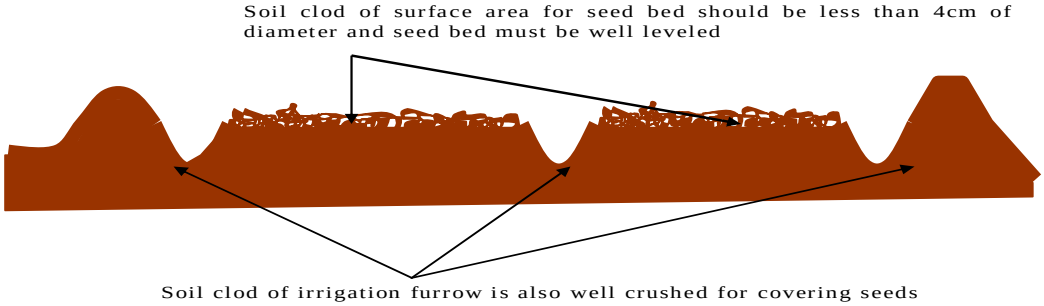


Figure 1.13: Soil clod crushing

5) Seeding

Pre-treated seeds should be scaled and the designated volume of such seeds should be sown equally spread.

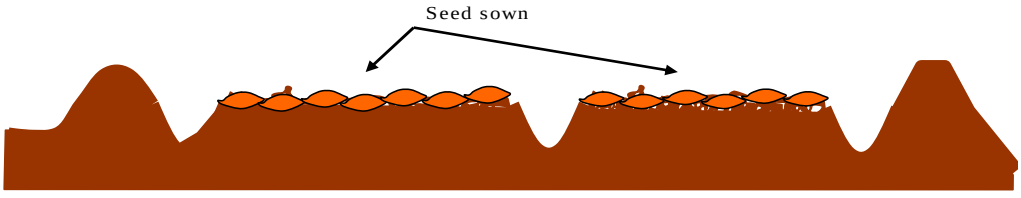


Figure 1.14: Seed sowing

6) Top-dressing

After seeding, seeds should be covered by top soil by using a rake and mixed with the soil to the depth of 2 to 3 cm. After mixing, the entire bed should be covered by another layer of fine soil, since approximately 20% of seeds are exposed. This is to help prevent birds eating exposed seeds.

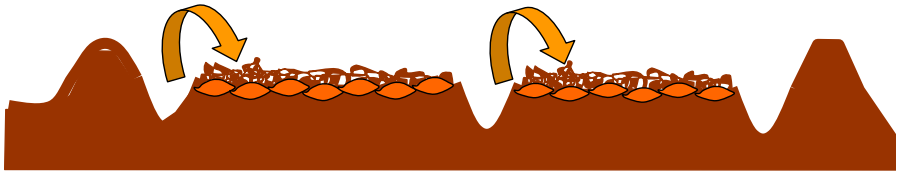


Figure 1.15: Covering seed

3.2.3. Irrigation Method

1) First irrigation

The first irrigation shortly after seeding is a very important factor to determine the rate of germination. Irrigation water should be maintained within the irrigation canals and should not cover the bed completely. This irrigation method is referred to as “seeping irrigation method.” This method maintains the soil aggregation structure relatively well while making seeds’ respiration easier. The rate of germination increases accordingly. On the other hand, if the bed is completely flooded, the soil aggregation structure becomes fragile, thus, causing the germination rate be lower.

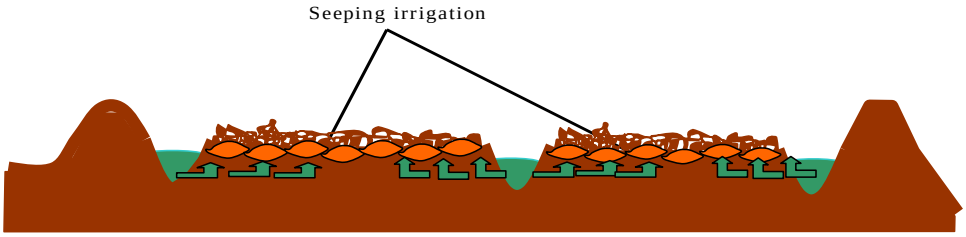


Figure 1.16: The first irrigation of seed bed

2) Method of the second irrigation and onwards

The application of the seeping irrigation method should be continued until approximately 60 to 70% of seeds germinate.

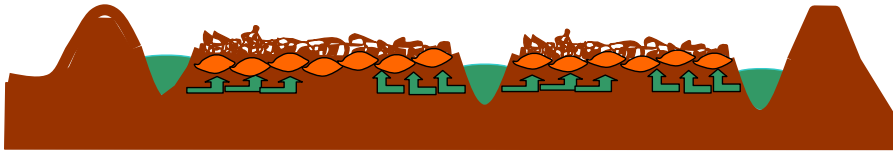


Figure 1.17: The second irrigation of seed bed

3) Irrigation method after germination

When approximately 60 to 70% of seeds germinate, the irrigation water should be lowered to the bottom of the bed. The irrigation water should be drained every two to three hours as well. The next step, transplanting, should take place as soon as the main paddy field is prepared, since the bed holds so many seedlings in limited space. The nursing period should be between twenty and thirty days and no more. It is very important to keep this

duration time in mind.

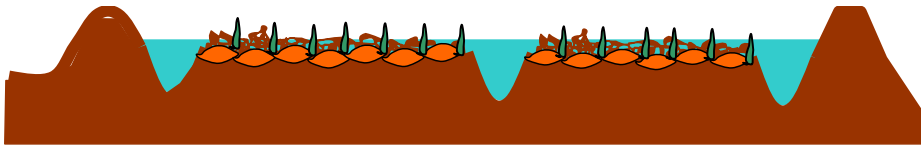


Figure 1.18: Seed bed irrigation after germination of seed

3.2.4. Seed bed management and nursery period

1) Seed bed weeding

Weeding work is needed from time to time during nursery period if weed comes out. If no weeding is practiced, many grass come out, seedling becomes small and tiny and establishment period after transplanting takes too long which finally results in reduced number of tiller number and panicle.

2) Urea top-dressing to seed bed

If leaf color becomes yellow at middle stage, apply urea 3-5 g per m^2 ($400m^2$=2 kg, 500 m^2=2.5 kg). But, don't apply urea later than after half of nursing period.

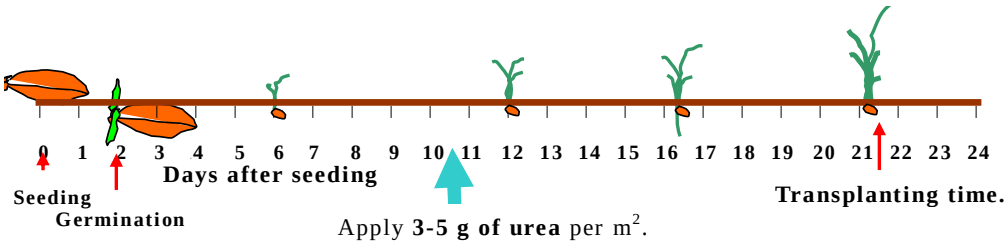


Figure 1.19: Optimum time for urea top-dressing to seed bed.

3) Water management of seed bed

- Just after seeding up to 7 days: Every morning, give water at about 1-2 cm height from the bed surface
- 7-14days: Give water every 2-3 days using the same method as above.
- 15days-transplanting time: Give water every 4-5 days, and give sufficient water 1 or 2 days before seedling uprooting work start.

4) Nursery period

Nursery period is very important for ensuring large and healthy tillers as well as big panicle size and large panicle number per unit area. Nursing duration must be between 21days and 30 days. Nursing duration of more than 30 days will usually cause un-seasonal sprouting of panicles just after transplanting, small panicle size and less panicle number per unit area.

3.3. Main paddy field preparation

The main paddy field for this project begins with the rough plowing process at the field where there is no previous crop. It is usually done in the rain in October and November. The rough plowing is done by the large scale tractor (75-120hp) along with a disc plow.

Nevertheless, the field was not evenly plowed everywhere, leaving some parts unplowed. Furthermore, in the fields, where vegetables or maize were previously produced, the harvesting of these crops usually means a delay in the plowing for rice cultivation. Preparation cannot start until the middle to the end of November. The seed bed is established from the mid-October to the beginning of November at a corner of the main paddy field or of the previously cultivated field, near to the access to the irrigation water. Still, an excessive volume of seeds are applied to a very limited space (1/70 to 1/100 to the main field) under dry conditions.

As has been already pointed out after the first phase, the field preparation is a very important factor to determine the growing environment for rice seedlings. The quality of the field has a direct influence to the quality of the plants and their yield. This paper is an addition to the method of main field preparation with the use of a cultivator (a power tiller and a rotary) and a tractor (a tractor and chisel plow, a rotary), which were both donated during the second phase.

3.3.1. Plowing and clod crushing

There were a few beneficial facts recognized in plowing using a disc plow, a chisel plow and a rotary.

・Soil clods are better crushed and easily done with the use a chisel plow followed by a rotary.
・This decreased the efficiency of plowing by about 30%.
・The chisel plow maintains the even depth of plowing.
・By using both a chisel plow and a rotary, the horizontal soil movement is reduced.
・The work efficiency of a disc plow and a chisel plow is about the same. (It is 2.0-2.5hr/ha for a disc plow and 3.0hr/ha for a chisel plow.)
・For the crushing performance, it is better to use a rotary than a disc harrow, even though the working efficiency of using a rotary is 2.0-2.5hr/ha and is not as good as that of using a disc harrow of 1.0-1.5hr/ha.

Plowing field (previous crop of maize)

Plowing filed (no previous crop)

Traditional puddling and leveling

Well prepared field

Photos 1.3: Land preparation

Plowing by chisel plow

Soil condition after single rotary plowing and soil clod of 4 cm

Plowing by rotary (crashing soil clod)

Soil condition after double rotary plowing and soil clod of less than4 cm

Photos 1.4: Land preparation by chisel plow and rotary

3.3.2. Internal irrigation canal and plotting the field

After establishing the irrigation furrow canals, the next task is to divide the field and make

small plots. Here, the shorter side of the field is dealt with first. Considering inclination of the field, one plot should not be higher or lower more than 5cm from the plot next to it. Say, for example the longer side of this field is 100m, a method of plotting water intake and drain outlet should be done by using the table below as a reference.

Difference of level in water intake and drain outlet	Number of small plots	Difference of level in the small plot
25 cm	5 to 8	5 cm to 3.1 cm
50cm	10 to 15	5 cm to 3.3 cm
75 cm	15 to 20	5 cm to 3.8 cm

Having the field divided into small plots helps to manage the field, such as weed control and fertilizer application. It is generally very effective to minimize the weed when the field is completely covered by irrigation water soon after the completion of the transplanting process. The difference in the level position of each plot, where irrigation water would not suffocate the plants by completely flooding them, should be less than 3cm, no more than 5cm. Please keep in mind that it is highly recommended to use hands to finish the plotting process by moving soil from the lower plot to the higher plot, as it is usually the case that plowing by a tractor with a disc plow is not good enough.

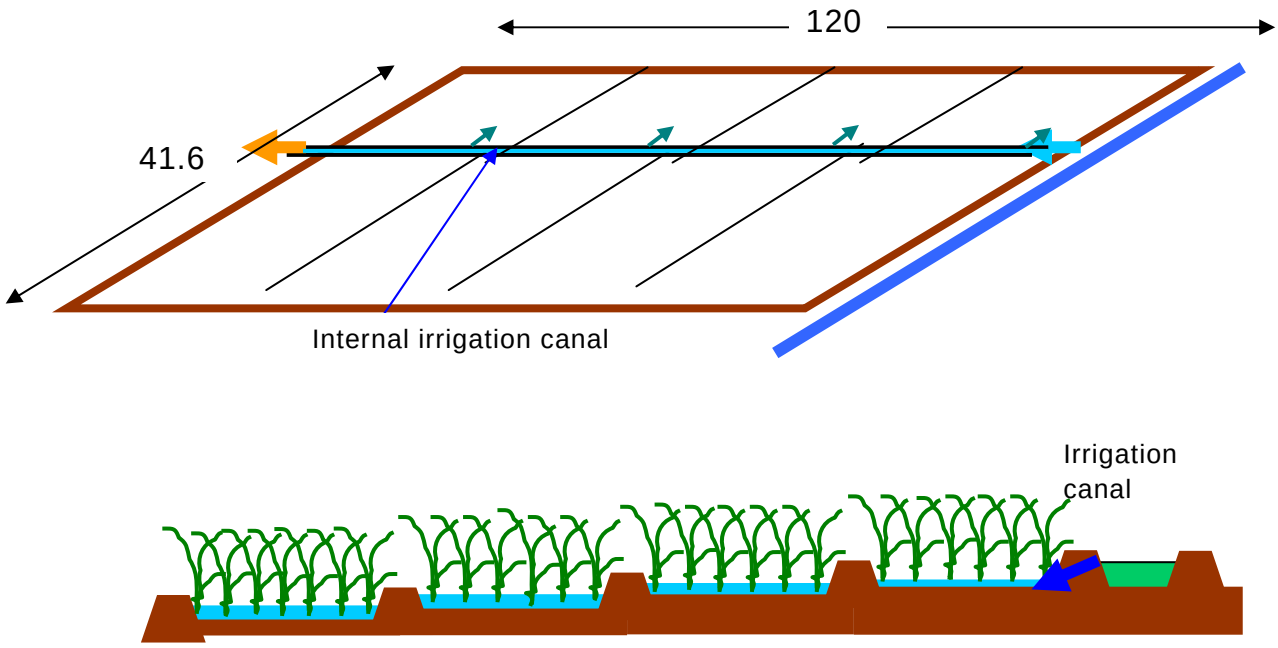


Figure 1.20: Well plotted field

3.3.3. Puddling and leveling by power tiller

The purposes of puddling and leveling the field are to eliminate the nitrogenous fertilizer caused by the decreased water requirement rate, to increase the effects of fertilizer application, to promote the growth roots and to minimize the growth of weed at the beginning of the plant growth stage through flooding the field, etc. One of the most serious issues to be concerned with is the extremely large water requirement rate

(approximately 40mm/day) often occurs between the transplanting and the beginning of the tillering stage. The change of the underground water level of the target region shows that the underground water level is the lowest during the time of land preparation to the beginning of the transplanting period. The level would gradually increase.

By February, in lowland area, the field will be completely covered by water. This flooded condition will remain until April/May. The water requirement rate is the largest at the time of transplanting lasting to the effective tillering period, which is presumed to be the cause of draining of the added nitrogenous fertilizer. Unfortunately, this phenomenon is making it very difficult to obtain sufficient number of panicles per unit area, resulting in having the unfavorable yield. This proves the importance of the adequate “puddling and leveling” to minimize the drain of nitrogenous fertilizer and to secure the sufficient number of panicle per unit area. What makes it easier to do the puddling and leveling is the power tiller. A performance test result proved its favorable performance and work efficiency. It was found to be possible to complete puddling a 0.1ha of field by the power tiller within about two hours average, after plowing, clod crushing and introducing the water. The duration of the leveling process may be influenced by the field inclination.

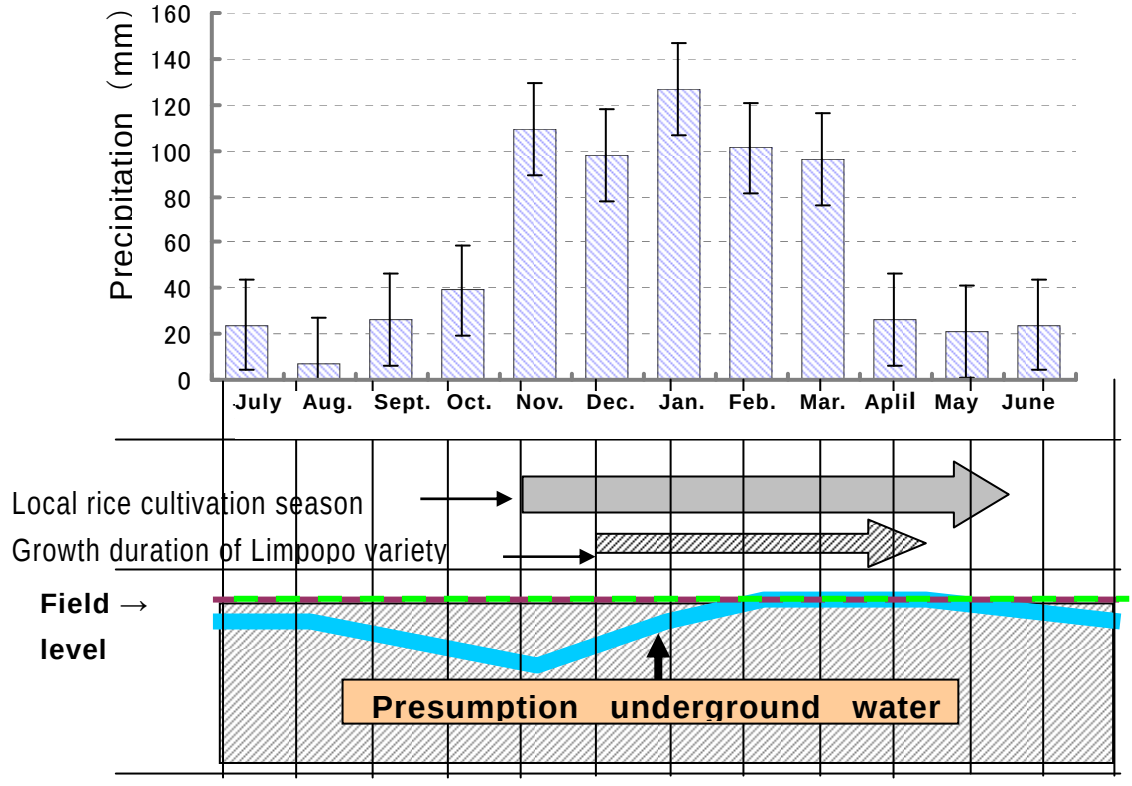


Figure 1.21: Annual precipitation and change of presumptive underground water level.

3.4. Transplanting

3.4.1. Planting density

The recommended planting density should be of 30 hills per m^2 (hill to hill's space: about 18cm between two neighbor hills). To obtain more grain yield, increasing seedling population per unit area is very effective and quick.

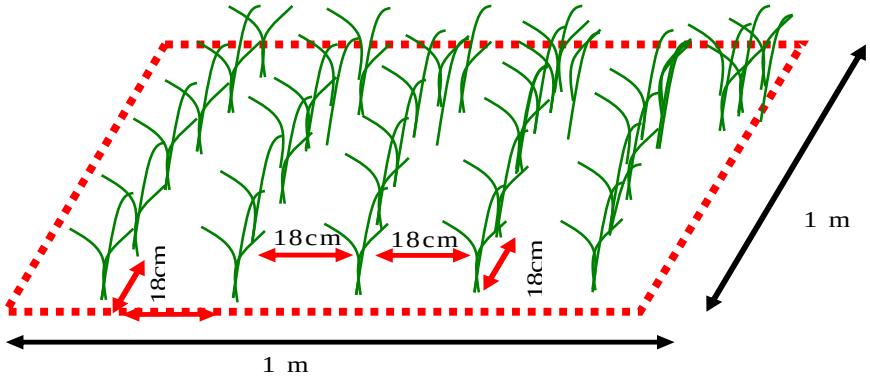


Figure 1.22: Image of 30 hills per m^2.

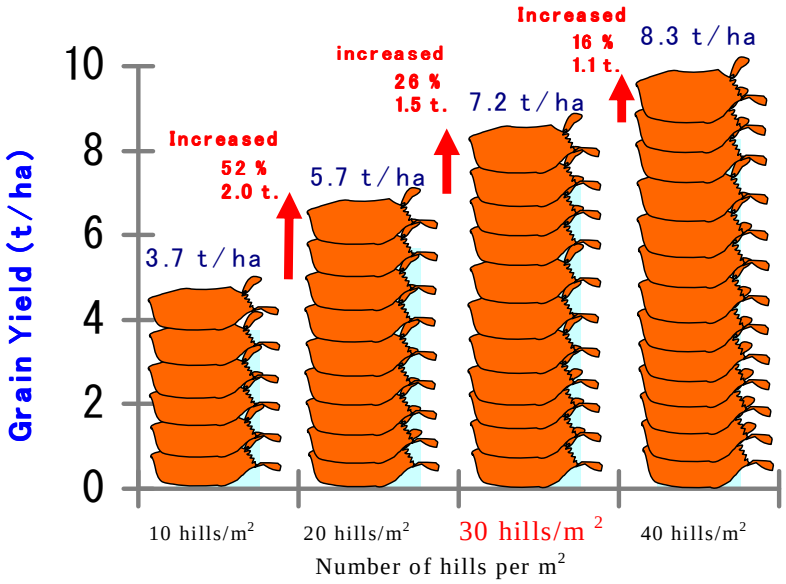


Figure 1.23: Effect of planting density on grain yield

The following technique can be pointed out for increasing panicle number per unit area;

Related technique for increasing the **"panicle number per unit area"**

Leveling of paddy field: Perform Puddling and leveling well.

- Planting density: 30 hills/m^2.
- Urea application: Apply urea 2 - 3 bags (100 – 150 kg) /ha.
- Urea split application: 2 times top-dressing 7-10 and 15-20 days after

transplanting.

- Use young seedlings: Strict observance of nursing duration of 21 – 28 days.
- Puddling and leveling: Strict enforcement of puddling and leveling.

Related technique for obtaining the optimum **"grain number per panicle"**

- Top-dressing just before the Reduction Division Stage.: 20-18 days before heading (see cultivation calendar).
- Use young seedling.

3.4.2. Number of seedlings per hill

The effect of number of seedling per hill was examined at Experimental Field in Research Station during 2007/08.

The highest yield was obtained in 6seedlings/hill but there was no significant difference among 3 seedlings/hill, 6 seedlings/hill and 9 seedlings/hill and yield of 1 seedling/hill was significantly lower than other seedling density. It can be concluded that optimum seedling number per hill is 4 to 6 seedlings per hill.

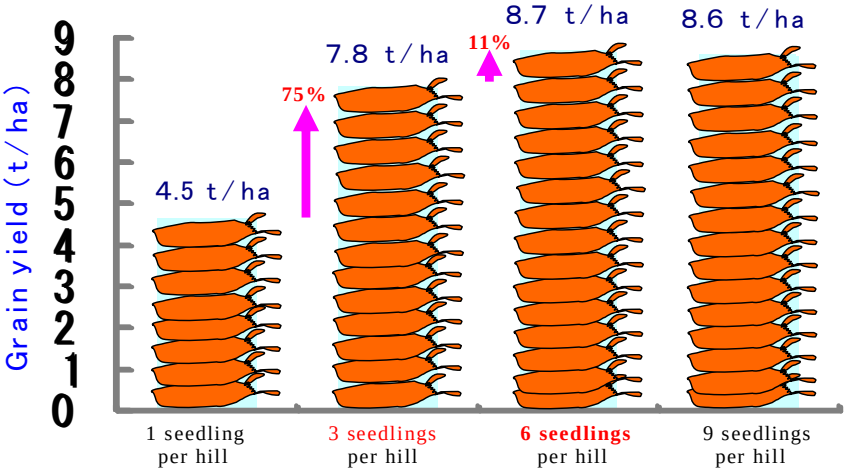


Figure 1.24: Difference of paddy yield by different seedling number per hill treatments.

3.4.3. Transplanting depth

Shallow transplanting is also an important factor for improving tiller outbreak during the effective tillering period. If transplanting has been correctly executed, i.e. in shallow depth, tiller outbreak is smooth from the rooting (setting) period (about 7 days after transplanting). By the contrary, if transplanting is carried out as deeply as 8-10 cm into soil, first few roots will come out from the bottom, then other roots will come out from upper node near soil surface. If this occurs, rooting period will take more than 2 weeks, and tiller outbreak will also delay and tiller number will be smaller.

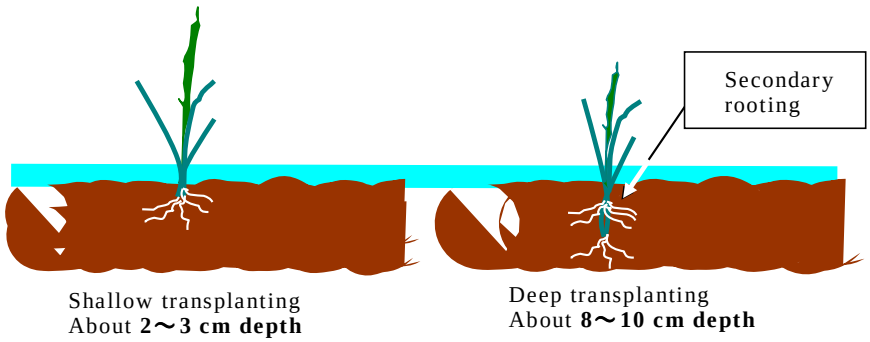


Figure 1.25: Comparison of shallow and deep transplanting.

In shallowly transplanted hill, new roots come out just after transplanting. But, deeply transplanted hill needs more days to complete the setting period, because in deeply transplanted seedlings secondary rooting occurs from upper node. This means that effective tillering period becomes shorter which eventually reduces tiller (panicle) number per unit area.

3.5. Fertilizer application

Today, high yielding rice variety has been widely introduced in this area. In case of cultivation of high yielding variety such as IT 312, IR 64 or Limpopo, nitrogenous fertilizer application is indispensable. Indeed, some times paddy yield is lower in high yielding variety compared with local variety if no fertilizer is applied. Fertilizer application is a crucial practice that allows for full appearance of the varietal characteristics. The minimum quantity of urea needed is 2 to 3 bags per ha, if one expects to get high effect, 1 bag of urea cannot be expected to provide high nitrogen effect.

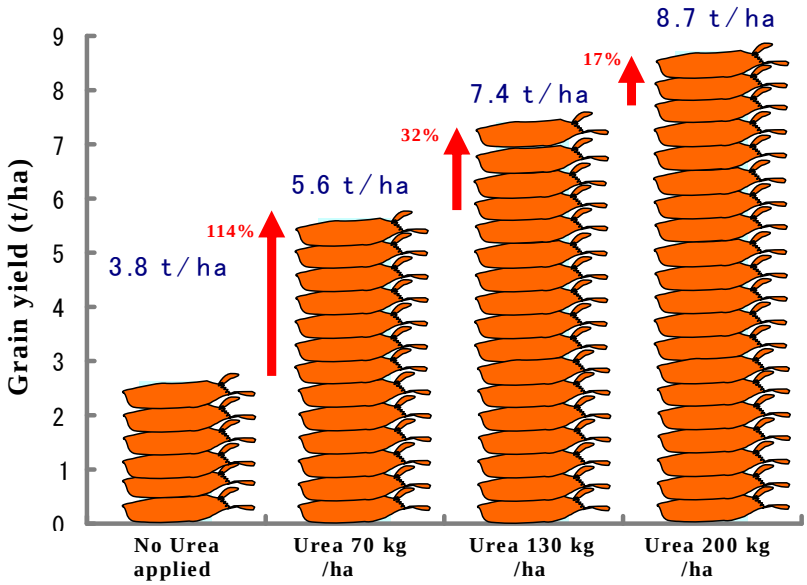


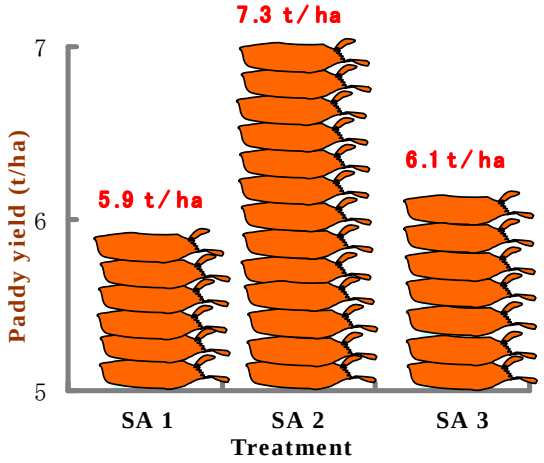
Figure 1.26: Effect of nitrogen application on grain yield

Finally, since urea application is crucial for obtaining higher paddy yield, we can recommend that 2 to 3 bags per ha be applied. Related technique to increase grain yield are as follows;

- Good puddling and leveling of main paddy field = Good land preparation,
- Seeding and transplanting at optimum time,
- Using young and healthy seedlings of 21 to 28 days.
- Planting density with 30 hills per m^2,
- 4-6 seedlings per hill,
- Shallow transplanting,
- Perform the weeding during the tillering stage,
- Optimum quantity fertilizer application of Apply urea 2 to 3 bags (100 – 150 kg) /ha.
- Optimum fertilizer split application of 3 times top-dressing;
  1st: 7 to 10 days after transplanting:
  2nd: 15 to 20 days after transplanting:
  3rd: 20 to 18 days before heading:

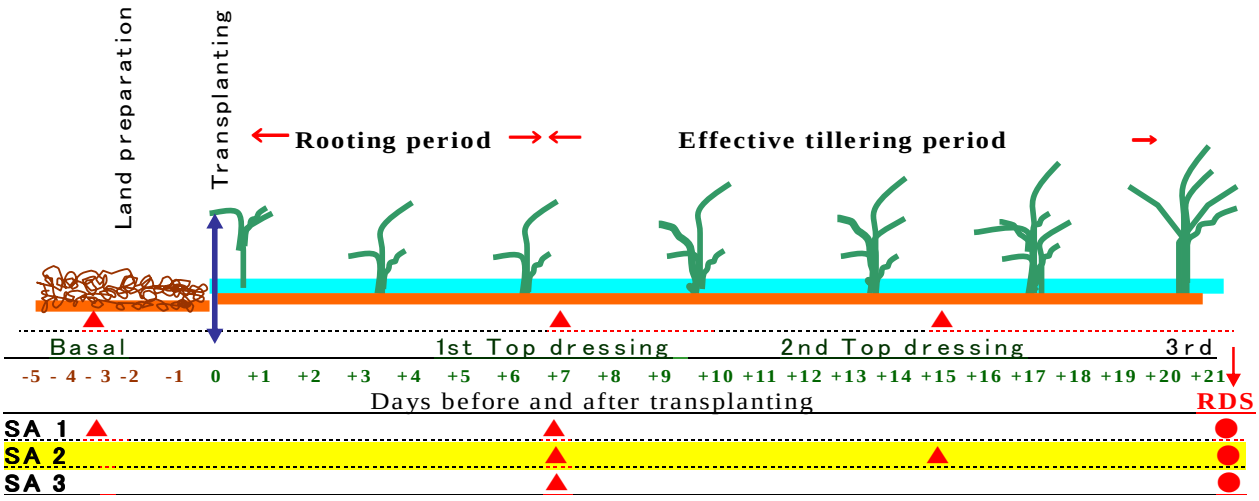
Split application method of nitrogen is the best way to minimize the loss of applied Urea due to vertical movement of water in paddy field. Instead of apply basal nitrogen; total amount of Urea (100 kg to 150 kg) is split in 3 times to assure high yielding. Following are recommended method of split application of Urea.

Split application	Kg of urea/ha	Time of application
1st top dressing	40 – 50	7 to 10 days after transplanting
2nd top dressing	25 - 30	14 to 20 days after transplanting
3rd top dressing	20 - 25	18 to 20 days before heading



Note:
SA1: SA1 (Basal 50% + 1st Topdressing 25% + 3rd Topdressing 25%),
SA2: SA 2 (1st Topdressing 50% + 2nd Topdressing 25% + 3rd Topdressing 25%)
SA3: SA 3 (1st Topdressing 70% + 3rd topdressing 30%).

Figure 1.27: Effect of split application of Urea on grain yield



Note. ▲ shows time of urea application.
RDS: Reduction Division Stage (18-20 days before heading).

Note:
SA1: SA1 (Basal 50% + 1st Topdressing 25% + 3rd Topdressing 25%),
SA2: SA 2 (1st Topdressing 50% + 2nd Topdressing 25% + 3rd Topdressing 25%)
SA3: SA 3 (1st Topdressing 70% + 3rd topdressing 30%).

Figure 1.28: Split application of Urea

3.6. Paddy field management

3.6.1. Weeding

Weeding work is very important especially up to Maximum Tiller Number Stage about 30 to 40 days after transplanting. During this period, the panicle number per unit area is determined which has strong effect on paddy yield. Therefore, weeding during tillering stage is very important work.

If there are many weeds during tillering stage, absorption of nitrogen by rice plant is hindered and photosynthesis is also reduced, and finally panicle number per unit area is lower.

3.6.2. Water management

It is important that deep water (4-6 cm) be maintained during the whole rooting stage, i.e., up to 7 to 10 days after transplanting. Deep water will also be needed during the last half of the growth stage, i.e. from the end of the Reduction Division Stage to the Milky Stage, which, in case of Limpopo variety is around 25th of Feb.-15th of March. From maximum tiller number stage to the beginning of the Reduction Division Stage intermittent irrigation can be recommended

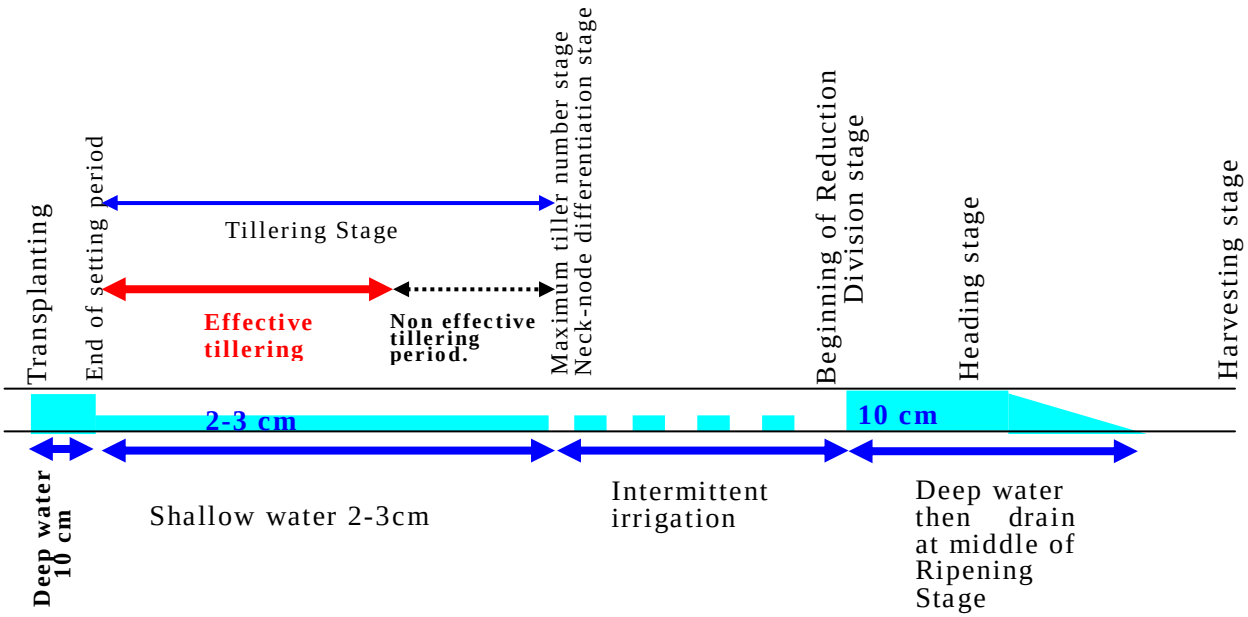


Figure 1.29: Water control method in total growth period.

4. Dry direct sowing cultivation method

4.1. Seed preparation and pretreatment

4.1.1. Seed procurement

Pure seeds can be purchased through the experimental station or local shops which deal with seeds. However, seeds bought at local shops may have a considerable amount of impurities among pure seeds, while the experimental station should offer pure seeds only. Of course the seeds collected by farmers' own fields are also fine for use (See "Rice Transplanting Cultivation Manual" for seed collection procedures). Approximately 130 to 140kg of seeds before selection process should be secured for every one ha of field.

4.1.2. Removing awn and impurities from seeds

Since it is often the case to find impurities among purchased seeds, seeds should be selected by the wind selection method, after awn of seeds are removed by an awner or being treaded within a tightly sealed bag. This process should be done properly in order to maximize the performance of the manual seeder.

4.1.3. Floating seed selection / drying the seeds

The paddy without awn should be selected by the gravity selection method (figure 1.30). After the selection, seeds should be dried in shades and be made ready for use as selected seeds. The gravity selection is to select fully matured seeds, which would sink to the bottom of a container. Those selected seed now needs to be dried in shades for twenty-four hours, spreading on a clean cloth, etc. It is important to mix them from time to time during the drying stage, in order to dry them evenly. Dried seed should be kept in a bag etc. until the seeding time.

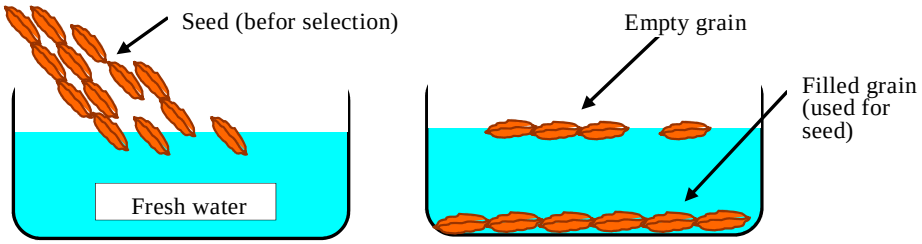


Figure 1.30: Seed selection by specific gravity of tap water

4.2. Applicable seed volume

(1) Volume of selected seed per ha of field

After removing awn, wind/gravity selected and dried seed should be weighed. The appropriate volume of selected (purchased, wind/gravity selected) seed for 1ha of field is between 100 and 120kg.

(2) Determining the appropriate volume of seed

The recommended volume of selected seed per ha of field is between 100 and 120kg. However, the final volume to be applied should be determined with a consideration of their germination test result.

Germination percentage	100%	:	120kg/ha
〃	90%	:	132kg/ha
〃	80%	:	144kg/ha
〃	70%	:	156kg/ha
〃	60%	:	168kg/ha

At least 150 germinated as well as established seedlings are indispensable for a field of 1m^2, in order to practice the direct sowing method. If possible, it is even better to have 200. When various field management procedures, such as fertilizer application, water management, weeding etc., are practiced, if 200 selected seeds are available, a good yield like 6 to 8t/ha may become a reality. Indeed, the most important technical factor when practicing the direct sowing method is to secure a good number of germinated and established seedlings per unit area. For a case of transplanting, the number of hills per unit area is almost guaranteed by using established seedlings. Therefore, it can be said that the yield of direct sowing depends on the result of germinating and establishing the rice plants.

4.3. Main Paddy Field Preparation

4.3.1. Weeding, removing residues of previous crop, rough plowing

The rough plowing of the field, where maize or other vegetables were cultivated previously, begins by the mid-October, after harvesting previous crops. The residues of previous crops and/or weed will tangle to the furrow cut of the manual seeder, preventing the seeder to cover the seeds with soil well enough. If such residues and weeds remain in the field, they would reduce the effect of nitrogenous fertilizer as they themselves would adsorb the nitrogen until they are completely rotten. Rice seedling require nitrogen especially during the tillering stage, so the first and second nitrogen application are crucial for guaranteeing enough panicle numbers per unit area. Applied nitrogen would dissolved into soil (at the time of the mid- to final growing stage of rice plants), after the residues are completely decomposed, and would be adsorbed by rice plants. Therefore, the residues of previous crops and weeds should definitely be removed from the main field.

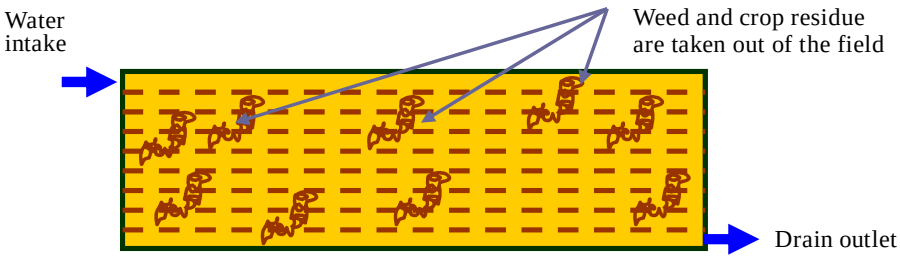


Figure 1.31: Extraction of weed and crop residues and plowing

4.3.2 Internal irrigation / drainage canals and plotting to the longer side of the field

After the rough plowing and until or at the time of clod crushing by disc harrow takes place, the internal irrigation as well as drainage canals should be established, being plotted parallel to the longer side of the field.

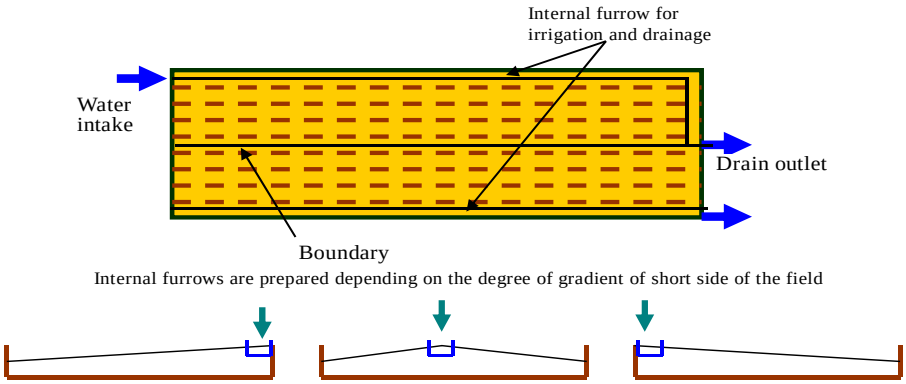
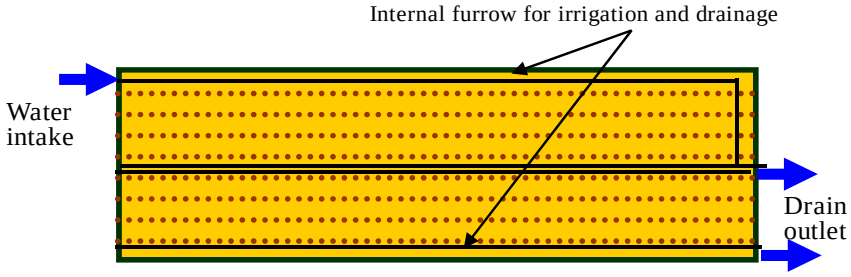


Figure 1.32: Furrow irrigation canal and ridge making in field

4.3.3 Clod crushing by chisel plow as well as rotary

The dry season cultivation (maize and other vegetables) should be managed so that their harvest can be started by the beginning of or middle of October. Then, the first rough plowing can take place by the middle of October. Clod crushing should be proceeded by disc harrow after a couple of rainy occasions. Clod crushing is most effective if practiced by fast revolving rotary after a couple of raining and drying occasions. One of the indications that the field is ready for seeding by manual seeder is the size of clod becomes less than 4 to 5 cm diameter (figure 1.33. and Photos 1.6). Clod crushing should be done thoroughly twice by tractor and rotary, then seeding can be done by manual seeder.



After two times of plowing by tractor and rotary cultivation, seed sowing by manual seeder

Figure 1.33: After harrowing soil clod crushing (clod size less than 4cm)

Photos 1.5: Soil clod crushing by rotary

Photos 1.6: Crushed soil clod after two times by rotary cultivation (no soil clod of more than 4 cm)

4.4. Seeding

4.4.1. Seeding by manual row seeder

Selected seeds of 100 to 120kg are sown by the seeder. The seeder can also cover the seed with soil; nevertheless, it is recommended to have one person walking behind the seeder to cover any exposed seeds casually by foot.

Seeding by farmers

Seeding by farmers

Modification to the curresnt coverage

Seed replacement

At 20 days after seeding by manual seeder (Verification field in D12)

Harvest stage (Verification field in D12)

Photos 1.7: Seeding by manual seeder

4.4.2. Establishing small plots parallel to the shorter side of the field

After sowing, the field should be plotted, first parallel to the shorter side of the field. The difference in plot levels should be kept within 10cm, by considering the inclination of the land. Say the longer side of the field stretches 50m, a plotting method of water intake and drainage outlet is;

Level difference of water intake and drainage outlet : # of plots : level difference of plots

Level difference	25cm :	5～ 8 plots :	level difference	5～3.1cm
〃	50cm :	10～15 plots :	〃	5～3.3cm
〃	75cm :	15～20 plots :	〃	5～3.8cm

To plot the field is quite influential to the percentage of germination and plant establishment as well as weed occurrence and the effect of fertilizer. After the end of plant establishment stage (3 to 3.5 leaf stage, approximately 5 to 7cm of plant height), it is effective to minimize weed occurrence by flooding the field. The level difference between small plots should be kept within 10cm so that the plant would not be under the water. Those small plots can be made manually by removing soil from lower level to higher level of the field, after the sowing. The furrow made by this process would serve as canals for seeping irrigation.

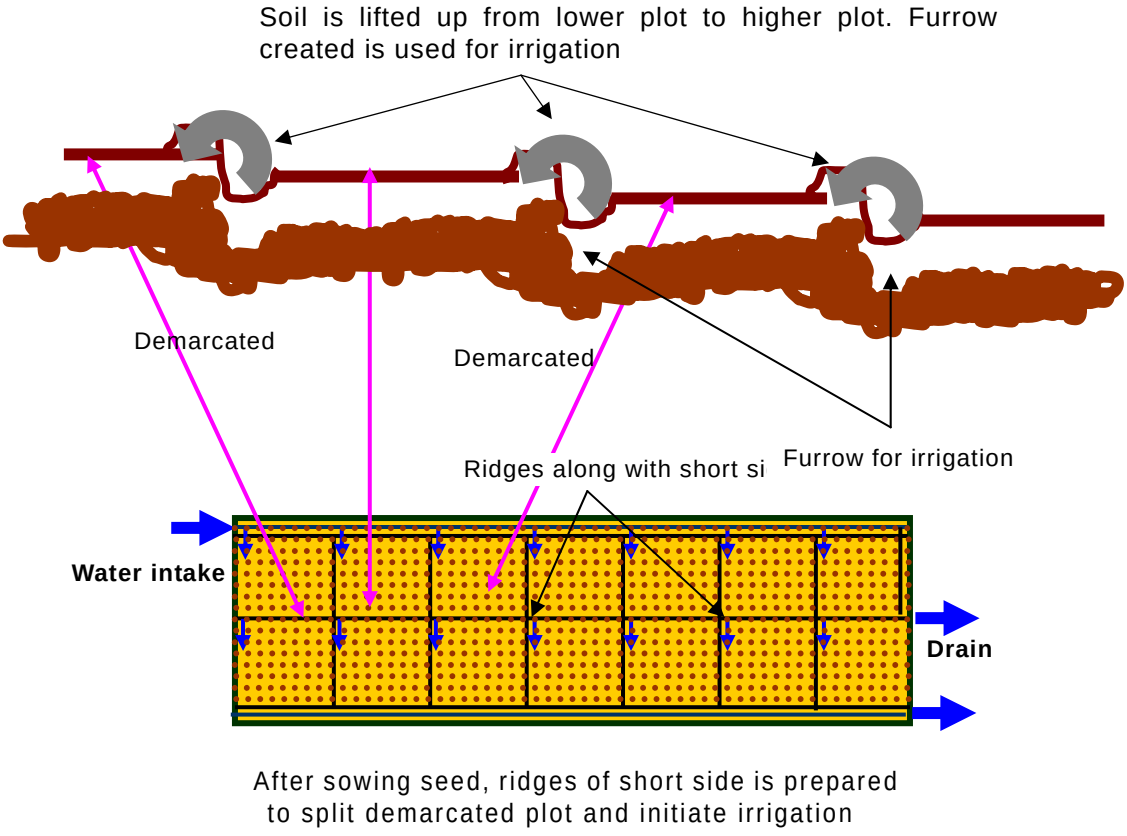


Figure 1.34: Plot demarcation and furrow irrigation canal after sowing seed

4.5. Irrigation

4.5.1. Method of the first irrigation soon after the seeding

The first irrigation soon after the sowing is so important that it can influence the germination. The “seeping irrigation” makes it possible to have high germination percentage. Just enough irrigation water can be introduced to small plots, where close attention can be paid, so that the field are not going to be flooded. The irrigation channel should be moved to the next plot when 90% of the soil of the previous plot become blackish with seeped water. The aggregation structure can be maintained relatively well in this way where germination can be encouraged.

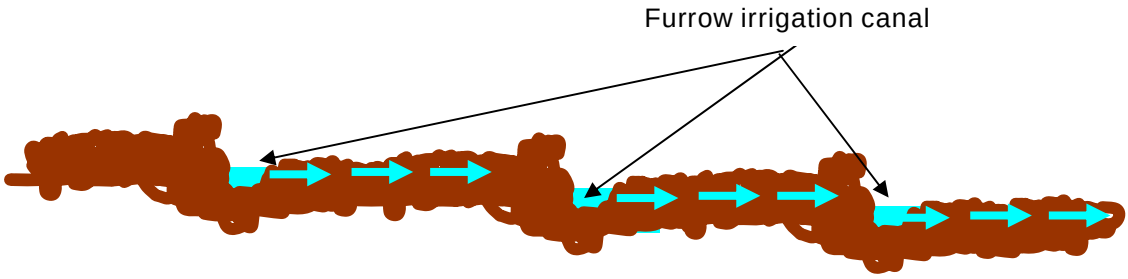


Figure 1.35: Irrigation of field by furrow irrigation canal

4.5.2. Method of the second irrigation and onwards

The second irrigation should be dealt with by paying close attention to the soil condition. It is optimum timing to apply the second irrigation when soil clod is whitish, dried and possibly even cracked. The seeping irrigation should be continued until the completion of germination and plant establishment.

4.6. Weeding

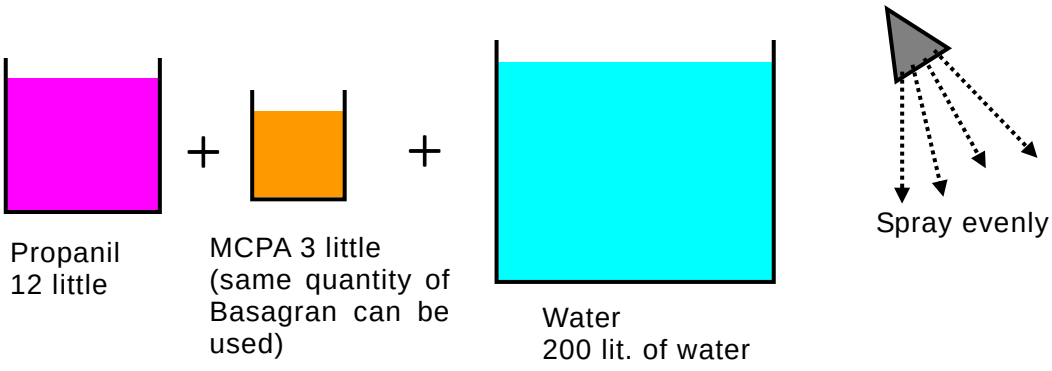
4.6.1. Optimum weeding time

Weeding should be done twice during the first half of the tillering stage and three more times in 70 to 80 days after sowing. The first weeding is spraying herbicide but the second and third weeding should be done manually. The weeding by applying herbicide may be very effective if done twice: once soon after sowing as well as the first irrigation and at the time of the end of plant establishment stage, and another one at the time of approximately twenty to twenty-five days after sowing (please refer the cultivation calendar).

4.6.2. Use of herbicide

Weeding is one of the most important technical aspects of the direct sowing method, along with land preparation and irrigation. Weed growth would cause the competition with rice seedlings, resulting a small number of panicles per unit area. At the mid-growing stage, the effect of weeds can overshadow the plant photosynthesis process and reduce the maturity percentage as well as the weight of a thousand grains. In recent years, herbicide has become available and more possible to obtain also in Chokwe. They have been applied widely.

Currently four types of herbicide are available in Chokwe: MCPA, Propanil, Basagran and Ronster. Those herbicide should be diluted by water and be made as a solution: 3 liters of herbicide to 200 liters of water, per ha of field. This solution should be sprayed to the field soon after the first irrigation (just before rice germination). The second weeding solution is a mixture of twelve liters of propanil and three liters of MCPA (or the same amount of basagran) with two hundred liters of water. This second solution should be sprayed to the field at time of 20 to 25 days after the germination. The effect is maximized when those solutions are sprayed at the recommended timing and evenly across the field.



4.7. Flood Irrigation

After the plant establishment, the growing process would proceed to the 3.5 to 4 leaf stage. The flood irrigation should be applied when the plant height reaches to 5 to 7cm. If the field is not sufficiently covered with water, weed will grow. So it is important to cover the field with water at an early stage of the end of plant establishment stage.

4.8. Fertilizer Application

4.8.1. Applicable volume of fertilizer

The optimum fertilizer dose is two to three bags of urea (100 to 150kg) per ha of field.

4.8.2. Application of nitrogenous fertilizer

There are two crucial factors to raise the yield. One is the number of panicles per hill and another is the number of paddies per panicle. The nitrogenous fertilizer should be applied at the beginning of the growing stage, in order to increase the number of panicle per hill. It is highly recommended to apply the fertilizer three times at different stages.

First application : 35% of the entire dose (52.5kg of urea), 4 to 5 leaf stage (about 20 to 25 days after sowing)

Second application : 35% of the entire dose (52.5kg of urea), 30 to 35 days after sowing (10 days after the first fertilizer application)

Third application : remaining 30% (45kg of urea), 65 to 70 days after sowing (30 to 35 days after the second fertilizer application)

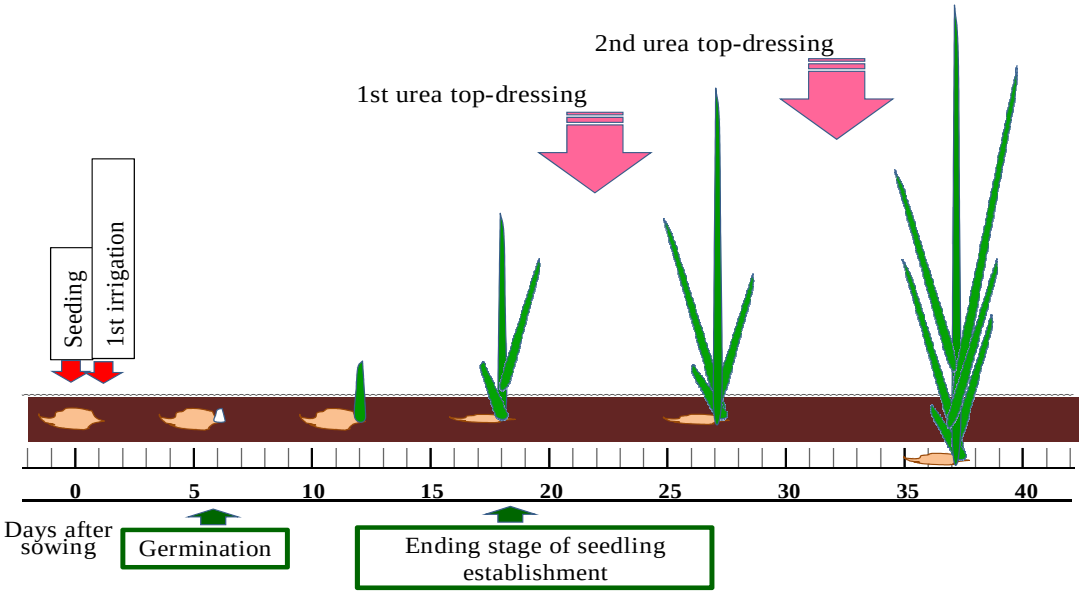


Figure 1.36: Time of Urea application

5. Harvesting

5.1. Optimum harvesting time is very important for ensuring good quality of rice.

It is internationally recognized that optimum harvesting stage is when grain panicles are 80% fully mature as shown below. When harvest occurs at this stage, high quality rice is produced with minimum harvesting loss. Passed the optimum harvesting stage, harvesting loss due mainly to rice grain cracking will increase day after day. Moreover, if harvesting work waits until all grains become yellowish, rice quality will rapidly decrease and harvesting losses will be higher.

If after the optimum harvesting time, rice is kept long time in fields in standing condition, grain cracking (upper half of panicle) even in high quality rice producing grains will occur. Rice cracking and cracked rice percentage will become higher and milling ratio will also be substantially reduced.

5.2. Threshing and drying

If harvesting and threshing are carried out under rainy condition, water content in paddy grain may be more than 15 % as moisture ; There is need for quickly drying it in the sunshine up to less than 15%. If it is kept in a bag with high moisture, rice quality decreases as rice color changes to yellow, mold outbreaks may occur and some time germination, depending on variety (on variety dormancy).

5.3. Rice milling

The rice milling percentage and rice quality are strongly related with moisture contents of paddy grain. Milling testing result with different grain moisture contents and husking and milling ratio indicated that best milling ratio is obtained between 15 to 13 % of grain moisture content.

6. Self-seed production

The farmer is doing home seed production mainly in rice producing countries, and never buys seeds so frequently. Rice varietal characteristics do not change under normal cultivation condition in several years. So, home seed production can be recommended in this area with following procedure:

Step 1: Seed and seed pre-treatment

- Use pure variety seeds at first.
- Strict enforcement of seed pre-treatment, seed selection work is especially important.

Step 2: Nursing

- Nursing by improved semi-dry bed style method.
- Nursing technique should follow improved method as above.
- During nursing period, extract the different shaped and taller seedlings
- Nursing duration must be respected: 21 to 30 days

Step 3: Transplanting

- Transplanting with normal cultivation method with 4-6 seedlings per hill, 30 hills per m^2 and shallow transplanting.

Step 4: Field management and fertilizer doses

- Weeding must be done from time to time and mixing weed and seed must be avoided.
- Fertilizer doses and water management are the same as for normal cultivation.

Step 5: Extraction of the different mixed varieties

- This **extraction work of different mixed varieties** is crucial for seed production. Extraction work needs to be performed at least 4 times during the total rice growth period as shown below (figure 1.37): during nursery stage, during tillering stage, during panicle initiation stage, and during ripening stage. The point of identification of different varieties at each extraction is that 1st and 2nd is height and leaf color of rice plant, 3rd is mainly height of rice plant, and 4th is maturity condition.

In case of Limpopo Variety: Total growth duration: 125 days

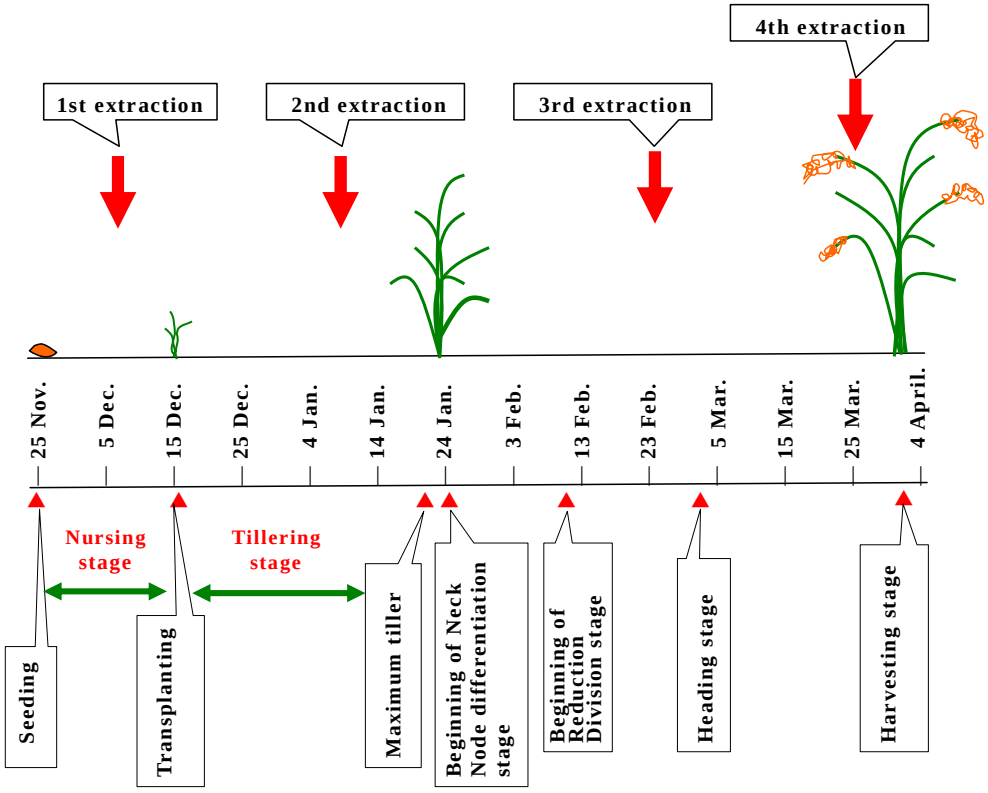


Figure 1.37: The extraction timing in total growth stage of rice.

- How to identify the mixed different varieties?
  - Plant height.
  - Leaf blade width and color.
  - Timing of ripening.

Step 6: Time of seed collection and method

The best period for practicing seed collection is when 80% of panicle is fully ripened. The big head (panicle)-selection method is used to collect only big and healthy panicles as shown below. The quantity of seed needed per ha is 80-90 kg at panicle collection time under condition of 18% of grain moisture.

Step 7: Drying and threshing

- The grain moisture percentage just after panicles collection is around 18% or above, and there is need for fast drying in the sunshine in order to decrease grain moisture down to 13% or even lower. Then, thresh, and keep it in a cool and well ventilated place.

CHAPTER 2

The management of Farmers' group

1. Establishment of Farming Support Groups : FSG

1.1. What are Farming Support Groups?

PROMPAC has adopted a "Farmer to Farmer" method to disseminate the rice cultivation techniques. The key player in realizing this dissemination among local farmers is the FSG.

- PROMPAC had organized a few training programs for FSG and loaned financial resources for them to manage their revolving fund.
- FSGs are to establish demonstration fields and participate in those training programs. Their revolving fund would be used for establishing and managing those fields.

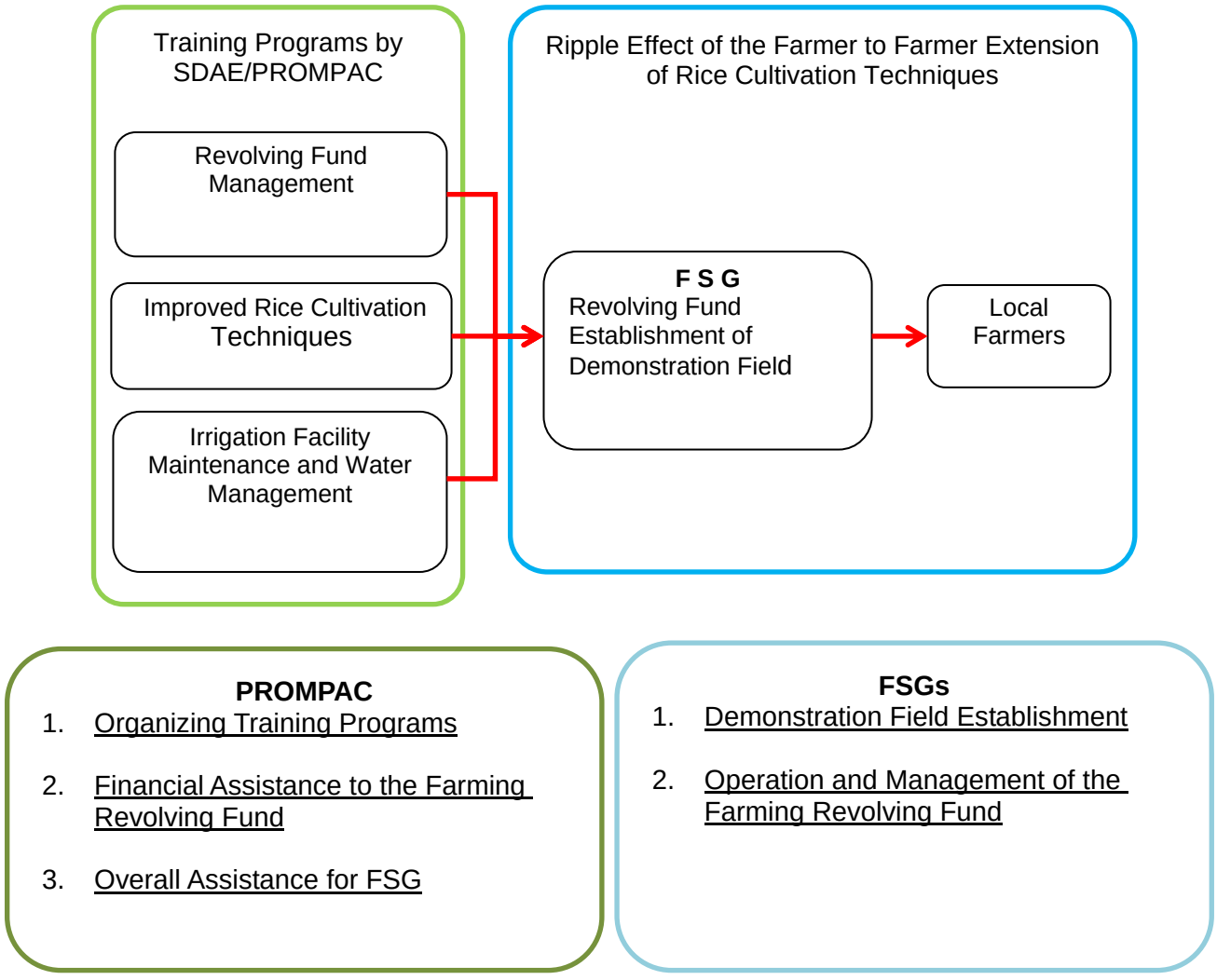


Figure 2.1: Objectives of PROMPAC and FSGs

1.2. FSG Establishment Procedures

1) SDAE/PROPAC Discussion

- SDAE explains the purpose and function of the FSG.

2) Member Selection

- Ideal number of members is between 10 and 15.
- Members will play leading roles to extend rice cultivation techniques.

- Members must be enthusiastic and participate proactively in rice cultivation.

3) Appointment of Executive Members

- President, vice-president and accountant should be appointed among members.
  - FSG is responsible for the personnel appointment.
  - Executive members must be literate.

①President

- Chief Executive of FSG
  - Represents FSG
  - Holds and presides meetings
  - Acts as a signatory to checks and accounting papers, along with the accountant
  - Acts as a liaison between SDAE and extension officers, etc.

②Vice-president

- Assistant to the President
  - Acts as a proxy in the President's absence
  - Executes missions instructed by the President

③Accountant

- Manager of the farming revolving fund
  - Collects farming revolving finance
  - Prepares cash at time of payment
  - Keep books
  - Deposits / withdraws money (deals with the bank)
  - Acts as a signatory to checks and accounting papers, along with the President
  - Prepares monthly reports

④Chief of Production (Additional)

4）Preparation of the Member List

- Makes the Member List including information such as (1) Full Name, (2) Residential Address, (3) Irrigation Area and (4) Contact Telephone Number.

5) Sign to the Agreement Between SDAE/PROMPAC and FSG

- Exchanges the Agreement between SDAE and FSG
  - Execution of training programs as well as loans for the farming revolving fund should proceed under this agreement.

An Example of Agreement

Agreement between the Project for Rice Productivity Improvement in Chokwe irrigation scheme (PROMPAC) and selected group of farmers in D5 of irrigators associations in season 2011/12.

Objective of Agreement

The purpose of this memorandum is for the PROMPAC and the group of farmers selected from D5, in relation to the activities that will be implemented by the PROMPAC to achieve the following results :
A) Disseminating improved transplanting rice cultivation technology, focused to small scale farmers;
B) Strengthen the activities of the Farming Support Groups (FSGs) in the area of the demonstration fields; increased the annual income of rice farmers in the region targeted by the Chokwe Irrigation System

Content of the agreement

1. The PROMPAC drew up the general plan of activities based on the Record of Discussion (R / D) and Project Design Matrix (PDM) , the results of the baseline survey (baseline survey) analysis and technical studies of the Chokwe irrigation system.

Technology transfer from farmer to farmer will be maximized with the dissemination of transplanting rice cultivation techniques to the target area of D5. In the plan, the PROMPAC decided to provide technical and financial assistance to establish demonstration farms by selected farmer groups, known as Farming Support Group (FSG) under the supervision of the area extension agent. The plan contains the activities as described below:

1) Assist in organizing and conducting training for FSG on rice production, and support the activities of FSG.
a) Establishment of FSG in Water Users Association in the area of establishment of demonstration fields,
b) Conduct training related to agricultural activities
c) Support the activities of the Farming Support Groups

2) Assist in the establishment of demonstration field on rice transplantation techniques with the initiative of the leaders of extension, extension agent and farmer leaders.

For implementation:
(A) Finance
The PROMPAC, through FSG, will provide a source of credit costs by 1 ha mentioned below.

Cost of land preparation (plowing) 2.200 Mt / ha
(Harrowing: Mt 1.100 x 2) 2.200 Mt / ha
Sub total: 4.400 Mt / ha
Cost of fertilizer (2 bags of urea / ha) Mt 1.550 x 2t=Mt.3.100 / ha

Cost seed Mt 60kg/ha, x Mt. 17/kg / ha= Mt1.020/ha
Total cost per hectare is 8.520 Mt / ha

(B) Technical Support:
The extension agent will be responsible for technical support related to the establishment and monitoring of demonstration field following the recommendations of "Manual of Rice Cultivation and transplantation of rice" developed by the previous project.

(C) Repayments of loans by farmers
The farmers / members who received credit would reimburse to the FSG with 10% interest per season at the end of the rice cultivation season.

(D) Supply of Credit Administration
Refunds will be administered by the FSG as a source of credit for the following season. The extension agent will oversee and assist in the administration of the fund, but the members of FSG have at the end a common responsibility over the administration of credit.

3) Assistance and training of farmers on improved transplanting rice cultivation techniques with initiative extension leaders (Training of farmers by extension workers and leaders extension, technology transplant rice)

4) Assistance and training of farmers on maintenance of irrigation facility and management of irrigation water use. (Training for farmers on maintenance and management of irrigation facilities, and water management at the farm level.)

2. In the above aforementioned assistance assumes that members of FSG, once FSG understand the contents of this agreement, accept and agree to work hard. Still, it is expected that members of FSG agree to implement the recommendations or proposals to be made by PROMPAC for the smooth implementation of the activities.

3. In case of any problem arising between FSG and PROMPAC during the execution of this Agreement, there shall be mutual consultations between PROMPAC and FSG in finding solutions to solving the problem

4. In case of problems remain between PROMPAC and FSG in the execution of the agreement, SDAE, EAC and HICEP will be requested to arbitrate and help solve the conflict.

5th. Regardless of consultations and arbitration referred to in paragraphs 3 and 4, if the FSG does not accept or show interest in implementing the recommendations given by PROMPAC, the project could unilaterally take action to tell FSG rupture of this Agreement.

Chokwe, November 22, 2011

2. Establishment and Management of Demonstration Fields

2.1. What are demonstration fields?

The demonstration fields will be established with the cooperation of PROMPAC and FSGs.

- The purpose of these fields is to demonstrate and extend the rice cultivation techniques.
  - PROMPAC organizes training programs for the purpose of improving rice cultivation techniques.
  - FSG members play a proactive role to extend those techniques to local farmers.

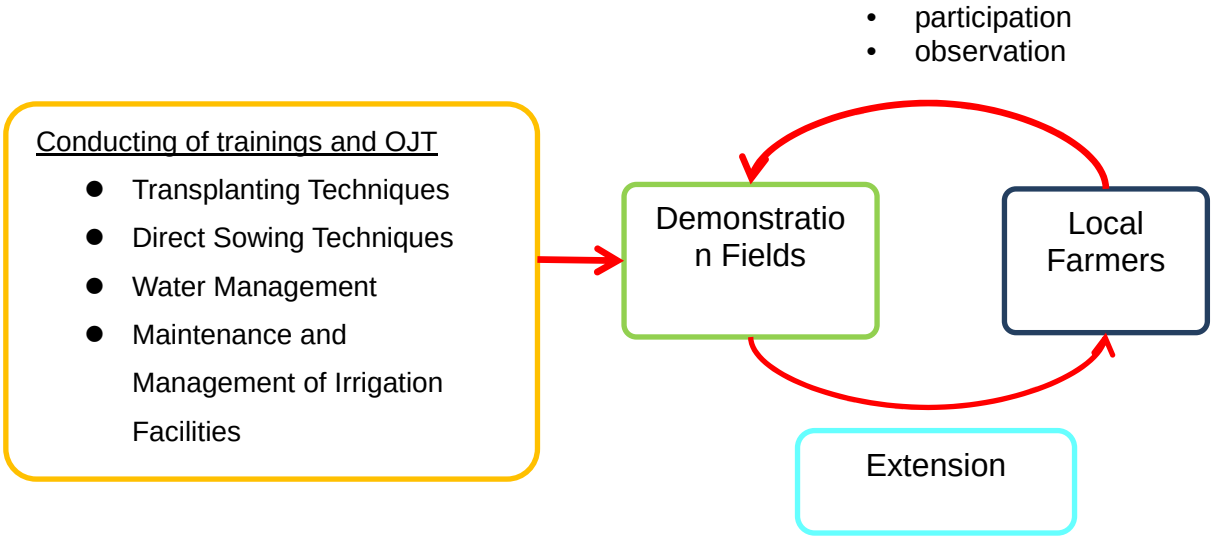


Figure 2.2: Functions of demonstration fields

2.1.1. Selection of Demonstration Field Location

Reasonable Fields

- Fields good for irrigation intake and drainage outlet
  - Check the condition of the tertiary irrigation and drainage canals
- Accessible Fields
- Fields without salt damage
  - Check the saline condition of the soil

Size of demonstration field per one farm household

- Transplanting farm: smaller than 0.5ha
- Direct Sowing farm : smaller than 2ha
  - The larger the fields become, the harder the management becomes.

Recommended Size for demonstration fields per one FSG

- 1 Ramal (13-16 ha)

2.1.2. Tractor procurement for plowing

- PROMPAC has assisted the plowing, harrowing and plotting
  - Plowing: 1 time
  - Harrowing: 2 times
  - Plotting: 1 time
- FSG procures a tractor(s) for plowing, harrowing and plotting.

- ➢ It is easier for a group to procure a tractor(s) than an individual.
- ➢ This is a benefit to form a group.

- It is necessary for FSG to make a clear agreement in advance with the operator, regarding the following points.
  - ➢ Price, payment method
  - ➢ Location of the fields
  - ➢ Duration of working time
- FSG members need to check the degree of surface level of the field, before paying for it.

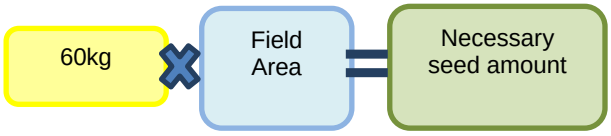
The fields must be leveled with clod adequately crushed and generally in a good condition.

2.1.3. Procurement of seeds

- PROMPAC provided the following.
  - ➢ Transplanting : 1ha: 60kg
  - ➢ Direct Sowing : 1ha: 150kg
- Above is the indicated sufficient seed amount.

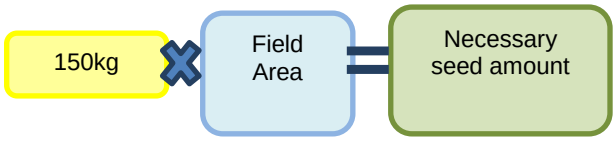
Calculation of necessary seed amount

- Transplanting



  - ➢ Necessary seed amount for a field of 0.5ha is:
    60kg×0.5ha=30kg

- Direct Sowing

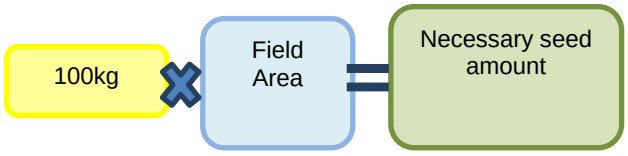


  - ➢ Necessary seed amount for a field of 2.5ha is:
    150kg×2.5ha=375kg

2.1.4. Procurement of fertilizer

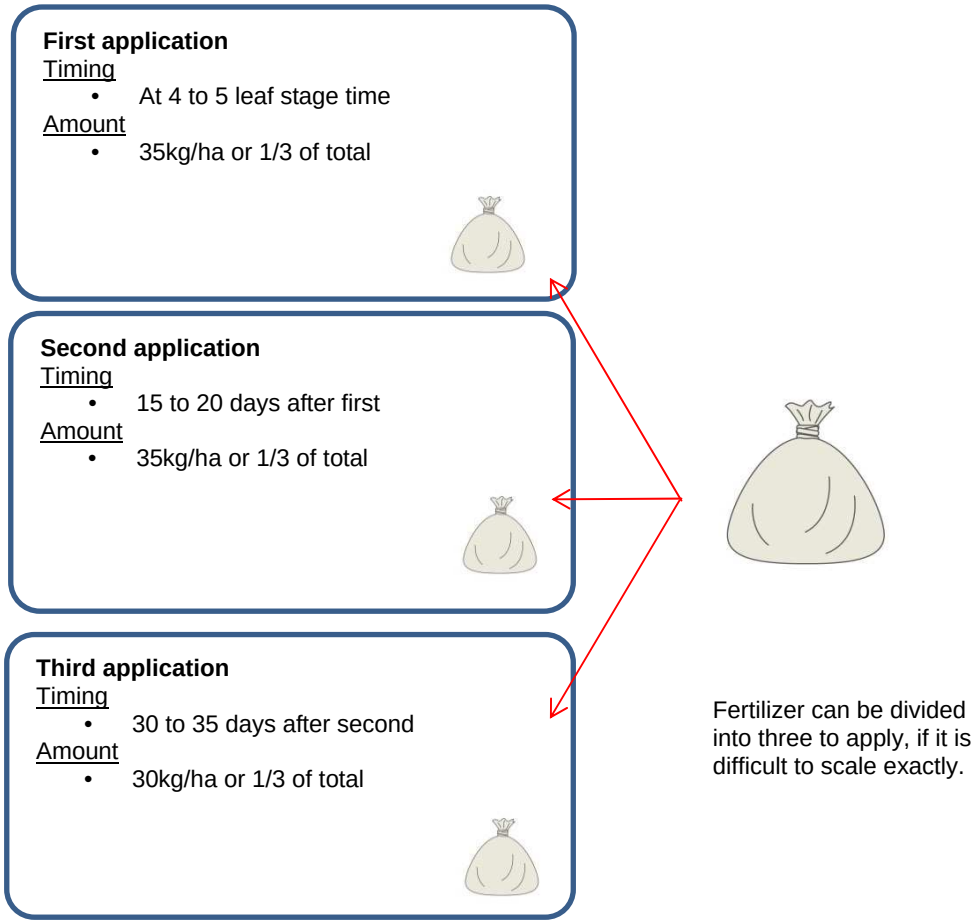
- PROMPAC provided 100kg/ha of fertilizer for target fields.

Calculation of Necessary seed amount



- ➢ Necessary amount of fertilizer for a field of 0.5ha is:
  100kg×0.5ha=50kg
- ➢ Necessary amount of fertilizer for a field of 2.5ha is:
  100kg×2.5ha=250kg

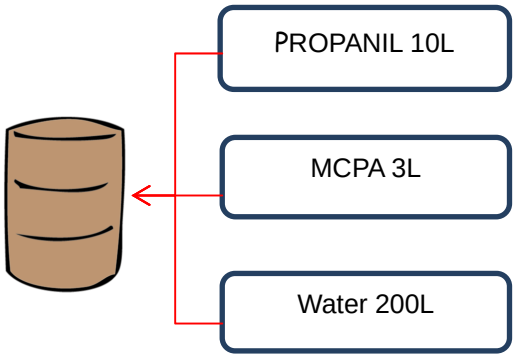
- PROMPAC recommends to apply fertilizer on three separate occasions.



2.1.5. Procurement of herbicide

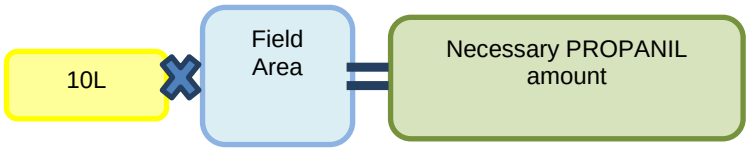
- PROMPAC recommends to spray herbicide to those fields sown by direct sowing.
  - PROMANIL : 1ha: 10L
  - MCPA: 1ha: 3L
  - Water: 1ha: 200L

- Herbicide application should be applied at the time of the 4 to 5 leaf stage.



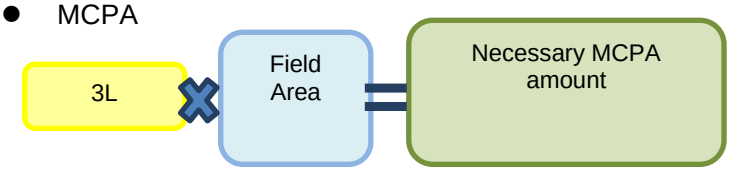
Calculation of necessary herbicide amount

- PROPANIL



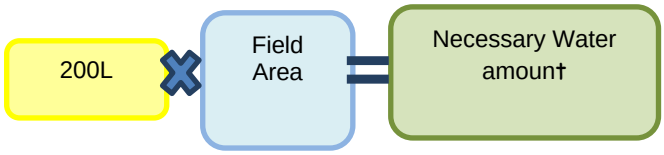
  - Necessary PROPANIL amount for a field of 2ha is: 10L×2ha=20L

- MCPA



  - Necessary MCPA amount for a field of 2ha is: 3L×2ha=6L

- Water



  - Necessary amount of water for a field of 2ha is: 200L×2ha=400L

3. Management of the Farming Revolving Fund

3.1. What is the farming revolving fund?

- PROMPAC offers financial assistance to members to do plowing, harrowing, and buy seed, fertilizer and herbicide (herbicide is only for direct sowing) so that FSG members would be able to establish demonstration fields relatively easely.
  - The financial assistance from PROMPAC is only given once, at the beginning.
- Members are required to repay the borrowed amount to FSG with interest.
  - FSG deposits the farming revolving fund to the bank account for the next cropping year.
  - Members return the money not for PROMPAC but for themselves.

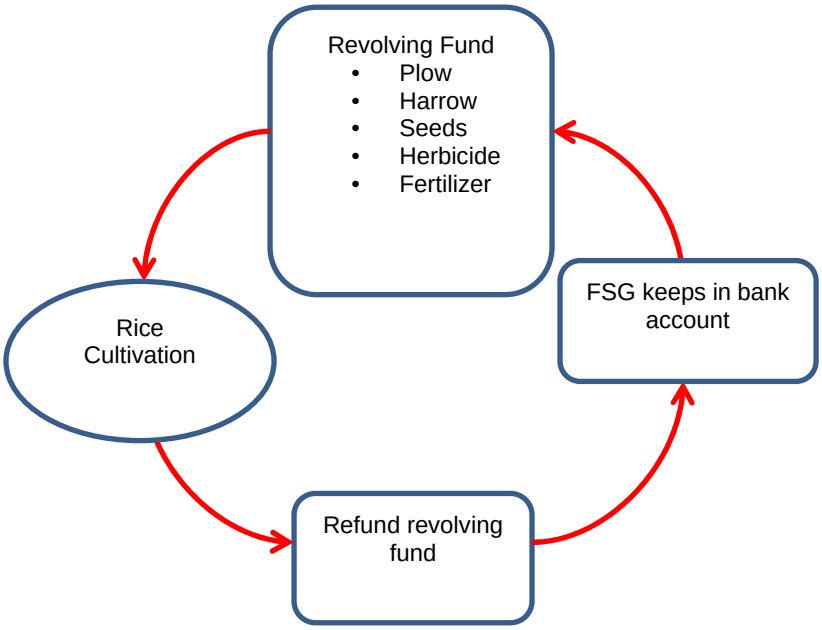


Figure 2.3: Functions of revolving funds

3.1.1. Preparation of the farming revolving fund

(1) FSG holds a meeting(s) to confirm the following points.

- Cash balance and account balance
- Members status of repayment (who finished the payment and who has not)

The accountant should bring the book and explain all accounting related information to the members.

(2) FSG should discuss how to deal with members who have not completed the repayment of the farming revolving fund. For example:

- FSG would not offer another loan until the repayment is completed.
- Other members pay off the amount on behalf of the member in question.

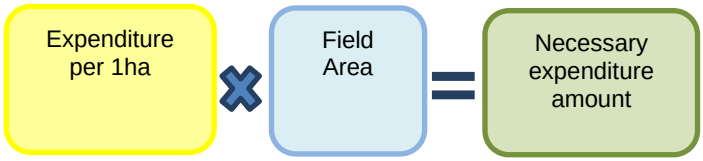
- Necessary expenditures should be agreed.
  - Plowing

- Harrowing
- Plotting
- Seeds
- Fertilizer
- Herbicide

- Necessary repayment amounts should be agreed.
  - Repayment should include the interest specified on the agreement.
- Any discussions and decision making processes should be done in the presence of all the members.

3.1.2. Calculation of Expenditures

Necessary expenditures should be calculated as follows.



The amount of expenditures per 1ha is specified on the agreement. The expenditure for a field of 1.5ha is as follows.

Expenditures per 1ha

- Plowing: 2,300Mt
- Harrowing: 2,300Mt
- Plotting : 750Mt
- Seeds: 150kg/ha×17Mt=2,550Mt
- Fertilizer: 2bags/ha×1,550Mt=3,100Mt
- Herbicide: 2,320Mt

Necessary expenditures are as follows.

- Plowing

2,300Mt×1.5ha=3,450Mt

- Harrowing

2,300Mt×1.5ha=3,450Mt

- Plotting

750Mt×1.5ha=1,125Mt

- Seeds

2,550Mt×1.5ha=3,825Mt

- Fertilizer

3,100Mt×1.5ha=4,650Mt

- Herbicide

2,320Mt×1.5ha=3,480Mt

- Total

3,450+3,450+1,125+3,825+4,650+3,480=19,980Mt

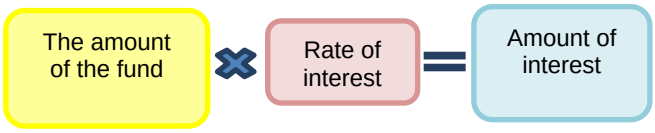
Any time the farming revolving fund is used, the accountant should record the amount spent in the book.

3.1.3. Calculation of the repayment amount

(1) Calculation of the interest

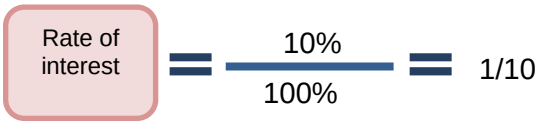
- Members must pay the repayment amount with the interest at agreed percentage.

The interest should be calculated as follows.



If the rate of interest is 10%:

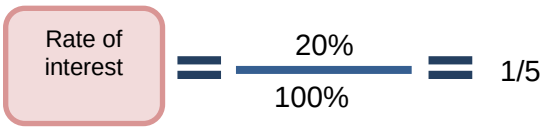
The 10% of the received amount would be the amount of interest.



- So, 10% = 1/10
  - ➢ The 1/10 of the received amount would be the interest.

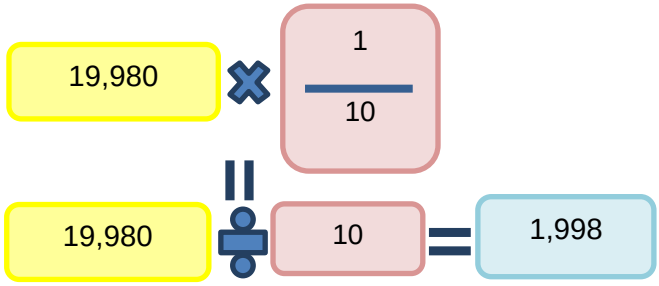
If the rate of interest is 20%:

The 20% of the received amount would be the amount of interest.



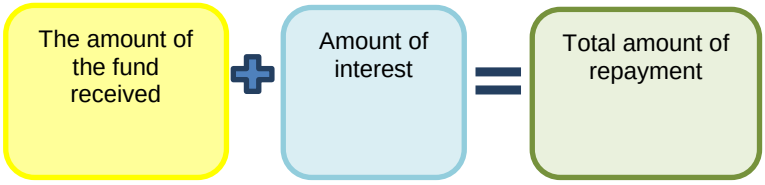
- So, 20% = 1/5
  - ➢ The 1/5 of the received amount would be the amount of interest.

- For a field of 1.5ha, one would receive 19,980Mt from the farming revolving fund. Its 10% (=1/10 of the received amount) would be the amount of interest. The interest amount should be as follows.



(2) Calculation of the total amount of repayment

The amount of payment is calculated as follows.



Therefore, the amount of repayment should be as follows.

19,980Mt+1,998Mt=21,978Mt

3.1.4. Collect the farming revolving fund

- FSG is to hold a meeting after harvest to confirm any matters concerned with repayment of the fund.
  - Amount of repayment
  - Term of repayment

- The accountant is the responsible personnel to manage the revolving fund.
  - The accountant should record the received amount in the book immediately after receiving any money.
- FSG should hold meetings even during the payout period, in order to share among the members the state of fund repayments.

3.1.5. Creating bank accounts for managing the fund

- Each FSG should make its own bank account to manage the farming revolving fund.
- Bank checks should be made to have a double signatory: the president and the accountant

- President and the accountant must agree on payment
- This is to prevent abuse of funds, which may be possible if only one person is in charge of the fund.

- The collected money should be deposited into bank as soon as possible.

Cash should not be kept in one's hands too long. There is always a possibility of losing or using this money.

4. Book Keeping

Year:

Month:

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Received	Paid	Balance	

4.1. Management of Accounting Books

- It is to record the handlings of the farming revolving fund.
  - Record every instance of money coming in and out.

4.2. Why is it necessary?

- To clearly understand who has and who has not completed the repayment to the fund.
- To clearly note the purpose and the amount that the fund was used for.
- To avoid building doubts among members by making the books transparent.

Therefore, it is necessary to record the following points.

- Dates
- Purpose of the money, from whom, to whom
- Received amount, paid amount
- Number of receipt, signature of person who paid the money, etc.

The book has three sections: cash account, bank account and individual farmer's account.

Cash account

This section is to keep track of cash flow.

Receiving Cash

1. Recovery of the revolving fund
2. Cash withdrawn from the bank account

Cash Expenditure

1. Expenditures of plowing, seeds, fertilizer and herbicide.

Bank account

This section is to keep track of deposits to and withdrawals from bank accounts.

Deposit

1. Deposit cash into the bank account

Withdrawal

1. Withdraw cash from the bank account

Individual farmer's account

This section is to keep track of each member's revolving fund.

Farming Revolving Fund

1. The spent amount
2. The amount of repayment
3. The amount repaid

5. The purpose of the Farmers' management group for rice milling machine

- PROMPAC supported the group to draw up a set of internal rules of the farmers' management group for rice milling machine. This manual explains matters related to their activities and provides rules to be uesed as a reference by the group.

Internal rules (examples)

INTERNAL REGULATION OF FARMERS' MANEGEMENT GROUP FOR RICE MILLING MACHINE OF D11

1. OBJECTIVES

The management of rice milling machine was entrusted with the Water Users' Association (WUA) of D11 by SDAE through a contract agreed to June 27, 2012, between the Director of SDAE (District Service for Economic Activities, Chókwe) and the president of IA of D11. However, this rice milling machine is run by a farmers' management group of rice milling machine selected from WUA of D11.

This regulation not only defines the functions and roles of the farmers' management group of rice milling machine regarding the operation and maintenance of the rice milling machine but also clarifies on the management of funds generated from rice milling activities.

II. FORM OF ORGANIZATION

1. Functions and roles of farmers' management group of rice milling machine

(1) Member

As a rule, members will play the roles referenced below and are selected once a year in the General Assembly and its terms of subscriptions are renewable.

1. President
2. Accountant
3. Assistant Administrator
4. Operator
5. Assistant Operator
6. Auditor (Appointed by WUA)

(2) Farmers' management group of rice milling machine

The group is entrusted by the WUA to operate the rice milling machine to help members of the WUA of D11.

(3) Roles of farmers' management group of rice milling machine

Through the effective operations of the milling machine and management of funds, the group will provide milling service for the members of WUA.

2. Role of members of the farmers' management group of rice milling machine

1) President
- Plans, directs and controls the activities through consultation with other members and extension staff.

2) Accountant
- Record all revenue and expenditures to the account book related to the operation of the rice milling machine.
- Deposit and withdraw cash with approval of the president.

3) Assistant Administrator
- Record daily operation and maintenance of the rice milling machine.
- Manage daily activities such as revenues, expenditures in relation to the daily operation of the machine.
- Keep record of meetings

4) Operator
- Operate and maintain the rice milling machine.
- Weigh paddy rice brought by customer
- Clean paddy rice before starting milling

5) Assistant Operator
- Support Operator

.

6) Auditor (appointed by the WUA)
- The auditor is appointed by the WUA and
- Attend regular meetings to verify and audit the accounts of the farmers' management group of rice milling machine.
- Verify and approve the annual accounts prepared for the general assembly.

7) Extension staff as technical supervisor of the group
- Extension staff is not member of the group.
- Participate in any meetings of the farmers' management group for rice milling machine and provides necessary technical advice to the group in relation to operation, maintenance management and financial affairs.

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3. Terms of the members

The terms of the members of the farmers' management group for rice milling machine is one year. All members should be approved by the General Assembly of WUA of D11.

Ⅲ Obligations of farmers' management group for rice milling machine

1. Provide milling services for both members and non-members of WUA of D11.

1. Users (customer)

Users need to request milling to the Assistant Administrator. Assistant Administrator and Operator will check the condition of paddy and remove unnecessary object such as stones, metals, and

grass seeds together with the user and if it is acceptable conditions, the operator will start milling. The users must comply with the payment of the amount stipulated for milling before starting milling. Only cash will be accepted.

2. Price
1) Rice Milling
Members of IA: xxMt/kg
Non-member of IA: xxMt/kg

2) Rice bran (for sale)
Members of IA: xxMt/kg
Non-member of IA: xxMt/kg

3. Control and record of the payment
The assistant Administrator must keep daily records of the operation of the rice milling machine based on the hours of operation, amount of milling, money received and expenses such as fuel, oil, salary and so on. The Assistant Administrator is entrusted with the control of daily work and passes all receipts to accountant every two working days.

4. Control money on accountant of the association to avoid risks
The Assistant Administrator must maintain daily activities of revenues and expenditures in the register while the accountant must verify and control the income and expenditure every week. Accountant is also deposit money into the bank account of the farmers' management group for rice milling machine once a week or twice to avoid the risk of theft.

2. Operate and maintain milling machine
1. Daily and periodic maintenance of the rice milling machine
The Operator as well as the Assistant Operator must make a daily inspection of the rice milling machine before starting the operation. The amount of oil, diesel and water remaining, condition of oil and diesel and condition of the straps etc. are to be inspected based on inspection sheet attached to the machine.
Any defects or failures occurring during the inspection should be reported to the extension staff through the President. If these defects or failures are difficult to manage, the president or extension staff should report immediately to the Director of SDAE for taking necessary measures.

3. Saving maintenance cost
Farmers` management group must save 2,000 Mt every month for the purpose of maintenance of the rice milling machine.

4. Hold Regular Meetings
The Farmers' Management Group of Rice Milling Machine will hold a meeting every month in order to review the milling activities (milling amount), to check account book (income, expenditure, balance) with auditor and to discuss any problems to be solved.

5. Report activities of the Farmers' Management Group for Rice Milling Machine to General Assembly of IA of D11 and get approval.

Items to be reported and approved are as described below;

1. Submit milling amount, income, expenditure and balance to be approved.
2. Milling price
3. Remuneration to members
4. Approve members of Farmers' Management Group for Rice Milling Machine.
5. Discuss any problems to be solved

Ⅳ. Rights of Farmers' management group for rice milling machine

1. Remuneration

The members of the farmers' management group for rice milling machine will perform their duties with a symbolic compensation based on the amount which is approved by the general assembly of IA D11 as indicated below:

Manager .... xxx MT/month
Accountant .... xxx MT/month
Assistant administrative .... xxx MT/month
Operator .... xxx MT/month
Operator Assistant .... xxx MT/month

2. Allocation of office and meeting place

The office for the farmers' management group for rice milling machine can be allocated where the machine is installed and all meetings are held in that place

5.1. What is the Farmers' management group for rice milling machine?

- IA commissions the group with the rice milling operation, as the group members are also members of IA.
- The group provides the rice milling service and manages the operation of the rice milling machine and its finance efficiently.

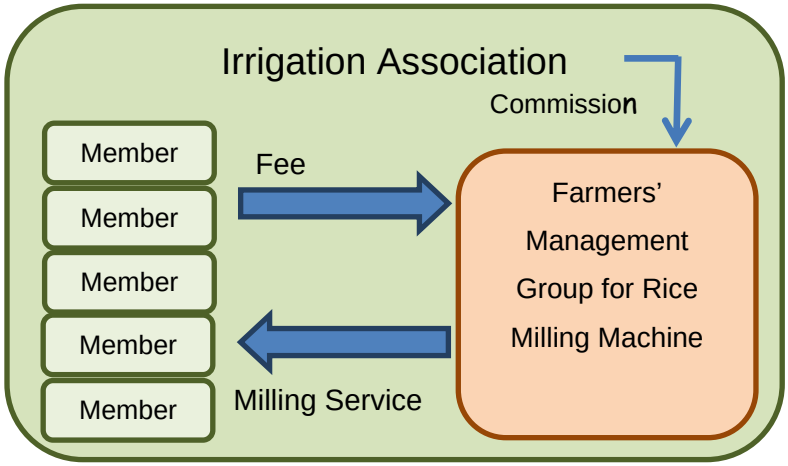


Figure 2.4: Functions of farmers' management group for rice milling machine

6. Members and their roles played by the members of the Farmers' Management Group for Rice Milling Machine

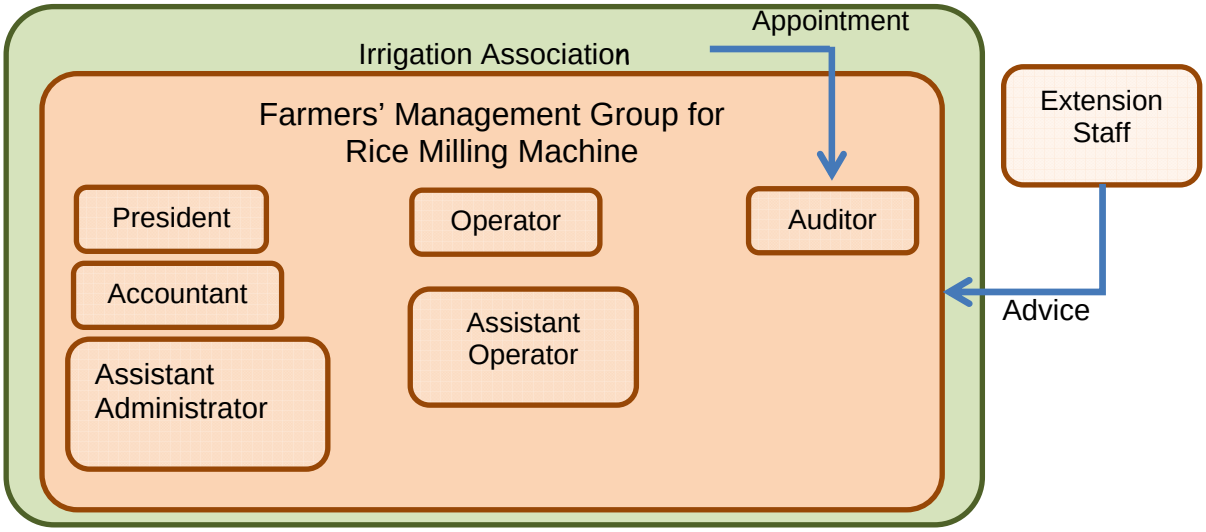


Figure 2.5: structure of farmers' management group for rice milling machine

6.1. President

- The president draws plans up, directs and supervises activities of the group, in cooperation with other members as well as extension staff.
  - The president has the responsibility of activities done by the group in general.
  - The president must be literate.

6.2. Accountant

- The accountant records all of the revenues as well as expenditure related to the operation of the milling machine.
  - The accountant must be able to calculate.
- It is necessary to have the president's agreement for any deposits to and withdrawals from the bank account.
  - The group needs to open its own bank account(s).
  - The president and the accountant should be co-signatory to the bank cheques.

6.3. Assistant Administrator

- The assistant administrator records daily operations and manages the maintenance of the milling machine(s).
  - The assistant administrator should be literate and able to calculate.

- The assistant administrator manages daily revenue and expenditure of the milling services.
  - Operation time, milled rice amount, revenue amount, expenses for fuel and oil, etc. are to be maintained in a written record every day.
  - The assistant administrator is to be responsible for daily operations.
  - Any receipts should be handed to the accountant every other day.
- The assistant administrator takes the minutes of meetings.
  - The following information should be noted.

- ✧ Date, meeting place
- ✧ Names of attendees
- ✧ Agenda
- ✧ Discussion details
- ✧ Discussion results (what were agreed/decided)

6.4. Operator

- The operator operates the milling machine and takes care of its maintenance.
  - ➢ The operator should be mechanically competent.

- The operator weighs the paddy brought in by members.
- The operator washes the paddy before milling. Any impurities, such as gravel or metal bits, should be removed before milling, since they may cause a malfunction in the machine.

6.5. Assistant operator

- The assistant operator assists the operator.
  - ➢ The assistant operator should also be technically competent.

6.6. Auditor (appointed by the IA)

- The auditor should be appointed by the IA.
- The auditor attends all the meetings of the farmers' management group for rice milling machine, checks the book and audits the accounting of the group.
- Checks the accounting report made ready for general meetings.

6.7. Extension staff as technical supervisor of the group

- Extension staffs are not the members of the group.
- Extension staff attends all the meetings of the group and offers advice on a number of their activities including the operation, management and maintenance of the milling machine, as well as the accounting issues.

7. Responsibility of the farmers' management group for rice milling machine

7.1. The group offers the service of rice milling to members as well as non-members of Irrigation Association.

7.1.1. Users

- Not only IA members but also non-members can receive the service.
  - The group is set up for IA members to get the benefits from the activity, but non-members are also able to receive the service.

7.1.2. Milling procedures

1. Anyone who wishes to have the service needs to apply to the assistant administrator.
2. The assistant administrator and the operator together check the paddy that is brought in, prior to the operation.
   - Any impurities such as stones and metal objects should be removed, as they may cause possible damage to the milling machine. Users remove impurities with the operator.
3. After removing impurities, the assistant administrator will weigh the paddy and calculate the fee.
4. Users will need to pay the fee to the assistant administrator, before the milling begins. Only cash is accepted.
5. After paying the fee, the operator begins the milling.

7.1.3. Fees

- Milling
  - IA members: xxMt/kg
  - Non-members: xxMt/kg
- Paddy (sales)
  - IA members: xxMt/kg
  - Non-members: xxt/kg

- If fees for the IA members are low.
- This is one of the merits that the group is made within IA.

7.1.4. Check and record the payment

The assistant administrator

- Is responsible for managing daily work and operations.
- Records the milling machine operation on daily basis.
  - ✧ All of the necessary information, such as operation hour, paddy amount, receiving money, paying money for fuel or salary, etc., should be noted and recorded.
- Hands over all of the receipts to the accountant every other day.

7.1.5. Manage the money

The assistant administrator

- Records revenue and expenditure on daily basis.

The accountant

- Checks revenue and expenditure on weekly basis.
- Makes the deposit to the group's bank every week. It is to avoid losing money and also money being stolen.

7.2. Operation of the milling machine and its maintenance

7.2.1. Maintenance of the milling machine

- It is necessary for the operator together with the assistant operator to check the milling machine before operating it every day. The following points must be checked every time.

Daily Check

- Engine
  - Fuel level
  - Engine oil level
  - Cooling water level
  - Water and/or engine oil leakage
  - V-belt tension check and adjustment
  - Tightening of nuts and bolts
- Rice milling machine
  - V-belt tension check and adjustment
  - Tightening of nuts and bolts

Every 50 hours

- Rice milling machine
  - Grease
  - Gear oil

Every 100 hours

- Engine
  - Change engine oil
  - Clean engine oil strainer
  - Clean air cleaner element
  - Change air cleaner oil

Every 300 hours

- Engine
  - Clean fuel filter element
- Rice milling machine
  - Refill gear oil

Every 600 hours

- Engine
  (ア) Change fuel filter element

- The operator needs to record operation hours. This would be helpful to predict the timing for the maintenance works, such as changing the oil.
- The president should report to extension staff any problems and issues that arise during the maintenance.
- If the above mentioned problems and issues are too difficult to solve among members of the group, either the president or extension staff should report to SDAE director promptly.

7.3. Reserve fund for maintenance cost

7.3.1. Maintenance Cost

- The farmers' management group for rice milling machine should have a reserve fund of 2,000 Mt for monthly maintenance cost.
  - The milling machine(s) will most definitely require maintenance repairs in the future.
  - An estimated maintenance cost should be considered as essential.

7.4. Holding Regular Meeting

7.4.1. Regular meeting

- A periodic meeting should be held every month.
  - To check milling business (milled rice amount)
  - To check the book with the auditor (revenue, expenditure and balance)
- Assistant administrator takes the minutes of the regular meetings.
- It is preferable for extension staff to attend those meetings.

7.5. Report the activities of the farmers' management group for rice milling machine at the IA general meeting

7.5.1. Report at the IA general assembly

- The group was established as an affiliated organization of the Irrigation Association (IA).
  - The group is responsible to explain IA about their activities.

Merit of being accountable to IA

- Explanation about the group activities will earn trust of IA members, while increasing its transparency.
- IA members would become to acknowledge the activities of the group well.
  - Everyone would become acknowledged about the group and its activities.
- It is well expected that accountability will reinforce the activities of the group.

If not being accountable…

- It may be possible for IA members to have a misguided belief or misunderstanding that only the management group members should be merited from their activities.
- IA would not be able to acknowledge the merit of having the group within IA.

Items to be reported and approved at the General Meeting

- Milling operation reports
  - Amount of milled rice, income, expenditure, balance
- Salary amount for the group members
- Milling fees
- Members of the group
- Other problems and concerns to be solved

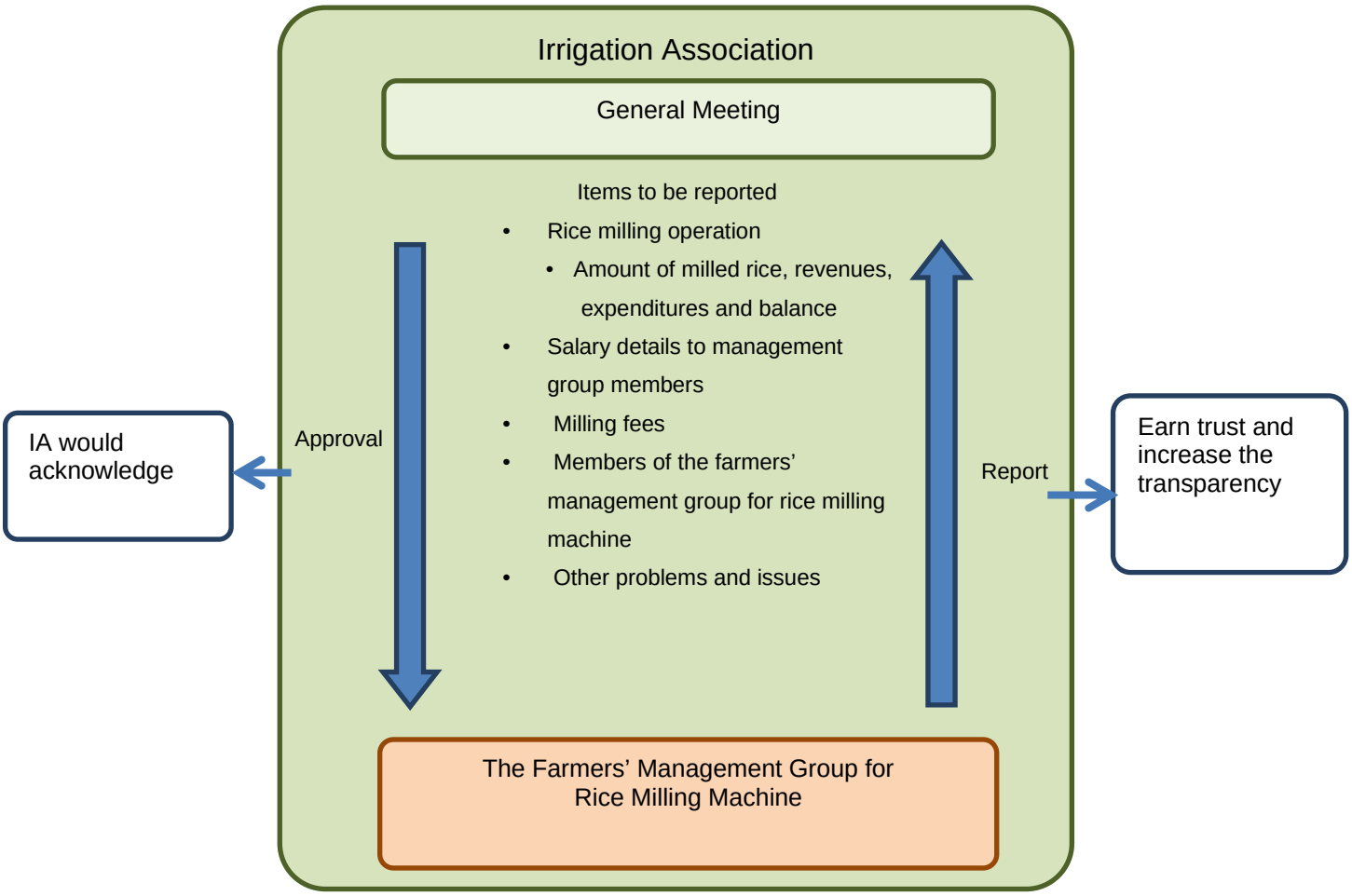


Figure 2.6: Relationships between General Assmbly and farmers' managemenrt group for rice milling mashine

8. The right of farmers' management group for rice milling machine

8.1. Salary

- The farmers' management group for rice milling machine approves its members or who becomes a member at the general meeting, and approved members should pursue their tasks and receive modest remuneration.
  - President: xxMt/month
  - Accountant: xxMt/month
  - Assistant Administrative: xxMt/month
  - Operator: xxMt/month
  - Assistant Operator: xxMt/month
  - Auditor: xxMt/month
- The following matters are the most important.
  - If IA members fully see and understand the merits of the farmers' management group for rice milling machine, they will show respect towards the activities of the group and appreciate to receive the remuneration.
  - Showing the accountability will make IA members understand about the merits of the group.
  - If the group fails to earn the understanding of IA members, the group may not be able to continue its activities.

8.2. Setting up a working office and a meeting space

- The working office should be located at where the milling machine is installed. Meetings and other gatherings should take place at this working office.

9. Management of the Accounting Books

Year:

Month:

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Received	Paid	Balance	

9.1. What is book keeping?

- It is to record the entire cash flow.

9.2. Why is it necessary?

- To clarify how much money came in.
- To clarify the purposes of the money spent.
- To clarify whether or not any profits are made.
- To eradicate any doubts by making the book open to members.

Therefore, the following items should be recorded.

- Date
- Purpose, from whom, to whom
- Amount received as well as amount paid
- Number of the receipts and signature of the person who paid.

The book has two parts: cash account and bank account.

Cash account

It is to record the entire cash flow.

Receiving Cash (4 items)

1. Milling fees
2. Paddy sales revenue
3. Cash withdrawn from the account
4. Others

Spending Cash (4 items)

1. Milling machine operation
   - ➢ Fuel, oil, filters, etc.
2. Maintenance of the milling machine
   - ➢ Spare parts
   - ➢ Repairs
3. Labor costs
   - ● Remuneration/Salary
4. Others
   - ● Travel expenses, etc.

Bank account

It is to record deposits to and withdrawals from the bank account.

Deposit (1 item)

1. Deposit cash to the bank account

Withdrawal (1 item)

1. Withdraw cash from the bank account

CHAPTER 3

Participatory water management and maintenance of irrigation facilities

1. Present Conditions

1.1. Chokwe Irrigation Scheme

In the Basic Design Study in 2001 by JICA, command area of Chokwe Irrigation Scheme (CIS) was 26,030 ha. Sowed area in recent 10 years from 2004/05 to 2013/14 is 7,150 ha or 28% in average. Harvested areas from 2008/09 to 2011/12 were more than 90 % of sowed area (93% of sowed area), but was 35% in 2012/13 due to damage by large flood.
The lowest rate of sowed area in the period was 8% in 2005/06 due to drought.

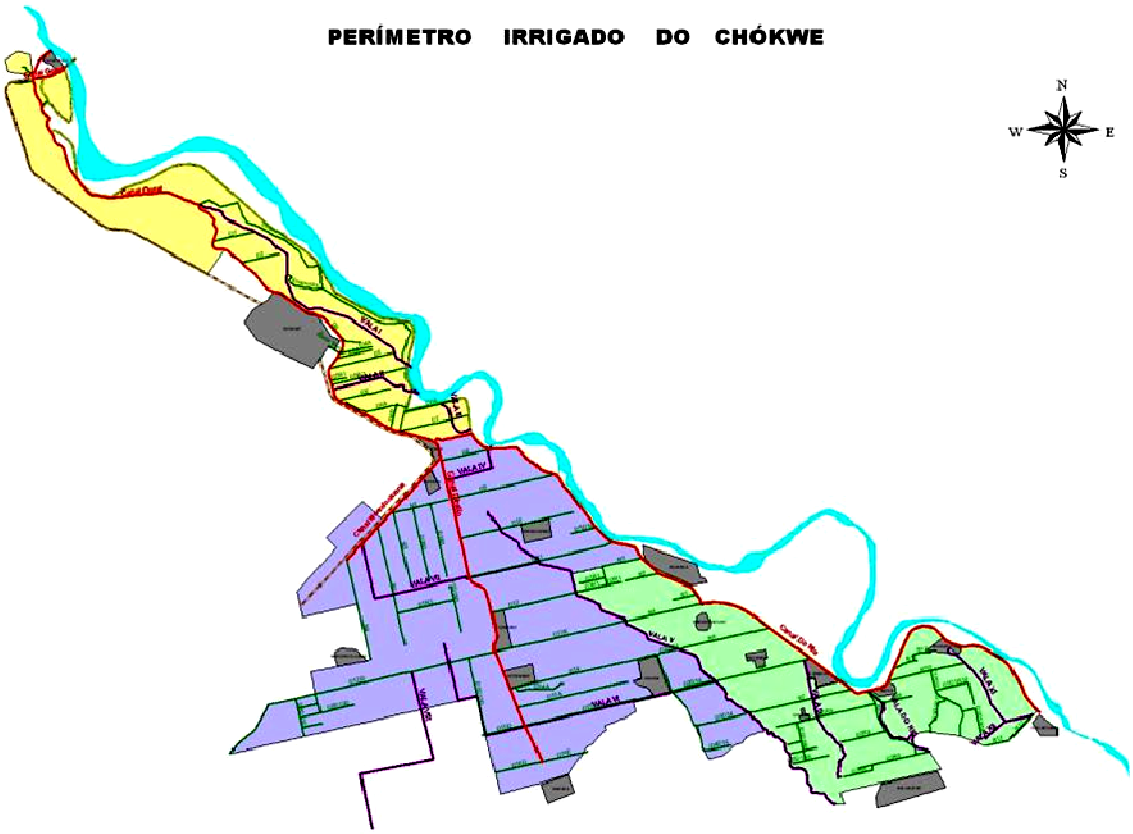
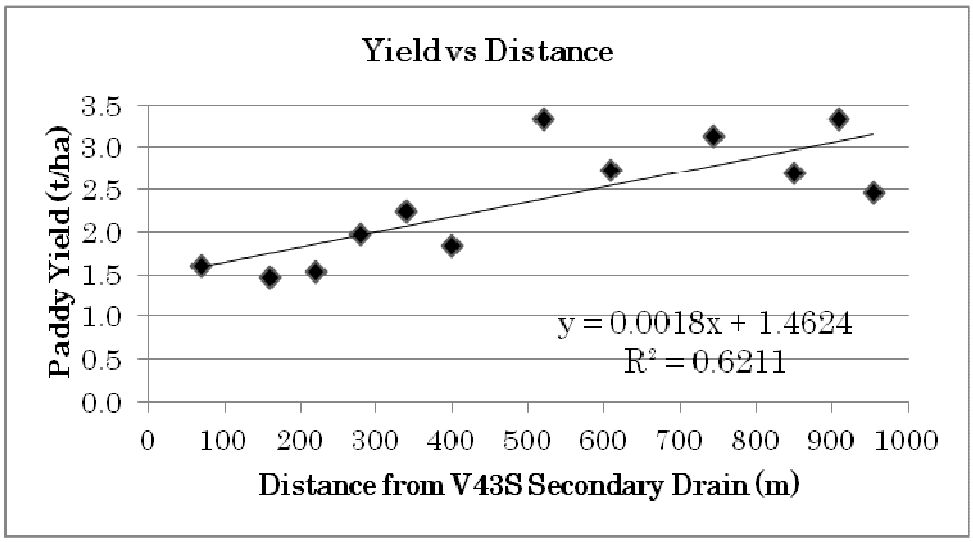


Figure 3.1: Command area of Chokwe Irrigation Scheme (CIS)

In Figure 4.2 of the Base Line Survey in 2011 by JICA, farmers ranked bad or poor drainage as the most serious problem of the irrigation system. It is confirmed again in the Project area through interview to farmers from 2012 to 2014.
It is noted that problem of insufficient irrigation water may increase as irrigation area increase from now on.
An example of relation between drainage condition and rice yield is presented in figures below.



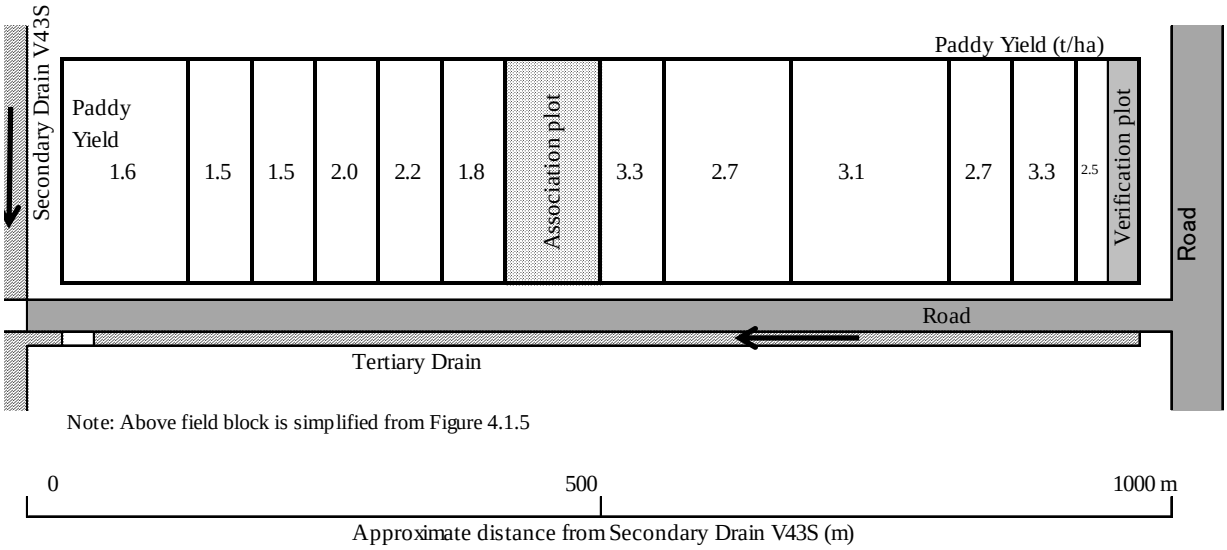


Figure 3.2: Rice yield by distance in D11 Demonstration Field of 2012/13

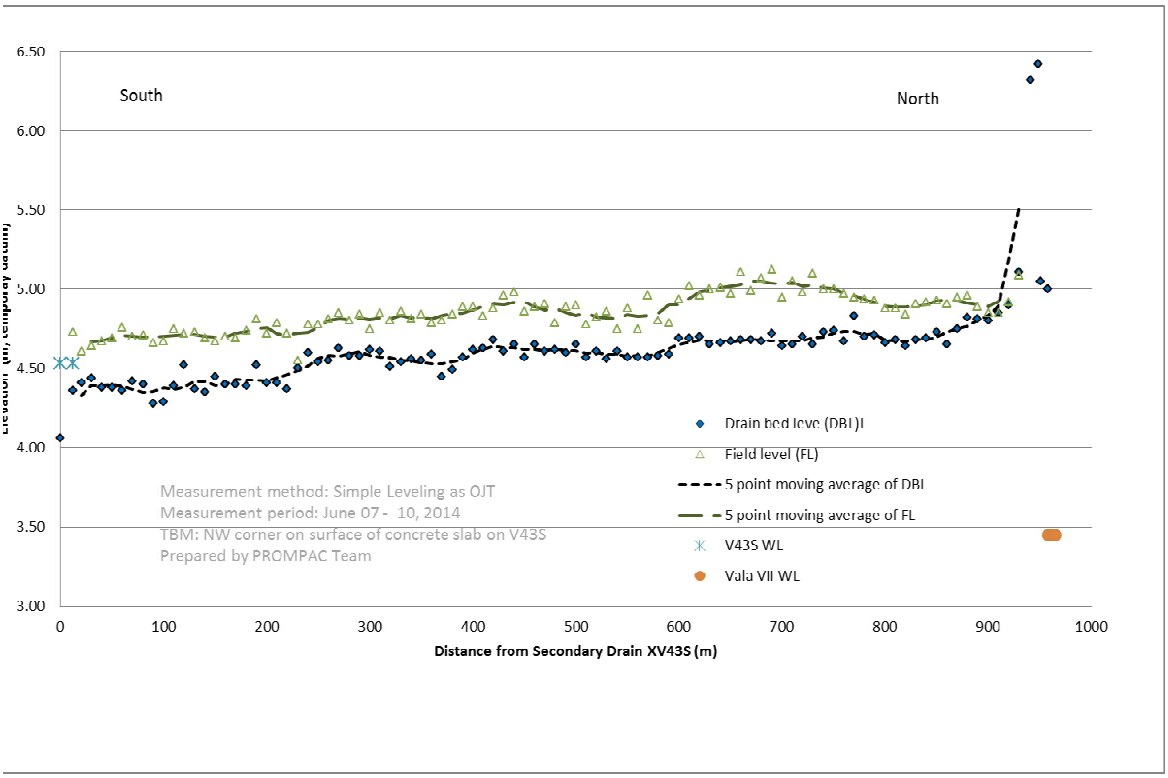


Figure 3.3: Profile of tertiary drainage canal between R16 & R18 in D11 area

In above case, drainage condition was worse near southern end due to high water level of the secondary drainage canal V43S in 2012/13.

1.1.1. Target area in the Manual

In the Manual, maintenance and water management in the on-farm level irrigation and drainage systems are topics, including tertiary irrigation canal, tertiary drainage canal and water management in farm lot.

1.1.2. Target user of the Manual

Farmers are expected users as well as extension members and cantoneiros. So, expression in the Manual is easy and simple using sketches, figures and photographs.

2. Maintenance of Irrigation and Drainage Facility for Improved Water Management

2.1. Tertiary Irrigation Canal

Tertiary irrigation canals were originally constructed as reinforced concrte flume called caleira. A part of the caleiras are utilized at present and earth canals are also widely used.
One of the serious interruption of the system is fall or missing of caleira and its support particularly at drain crossing. Replacement of caleira may need that of support.

Photos 3.1: Caleira and support rehabilitation (R14 TC in D11 in 2013)

Photos 3.2: Replacement by PVC pipes for 2 spans (R12 in D11 area in 2013)

Photos 3.3: Minor repair by cement mortar

2.2. Water distribution in field block or field lot (Ramal or cantera)

According to observation by the consultant team in the rainy season, lot (cantera, approx. 250m2) to lot water distribution method is usually selected, but water supply shifting is often not smoothly performed particularly after farmers leave from field. On farm water management is observed rather extensive and excess water remains sometimes in the field.

Cantera to cantera water supply may be adjusted automatically to certain extent using temporary low and small weir made by soil, wooden plate, or something like these. Farmers are expected to

learn better way through experiences for each case. Rotational water supply seems selected widely to each field lot in a ramal.

2.3. Tertiary Drainage Canal

There found several poor drainage areas due to improper tertiary drainage canal. These cases are common in CIS. Problems and countermeasures are discussed hereunder.

2.3.1. Difference between rice field level and tertiary drainage canal bed level

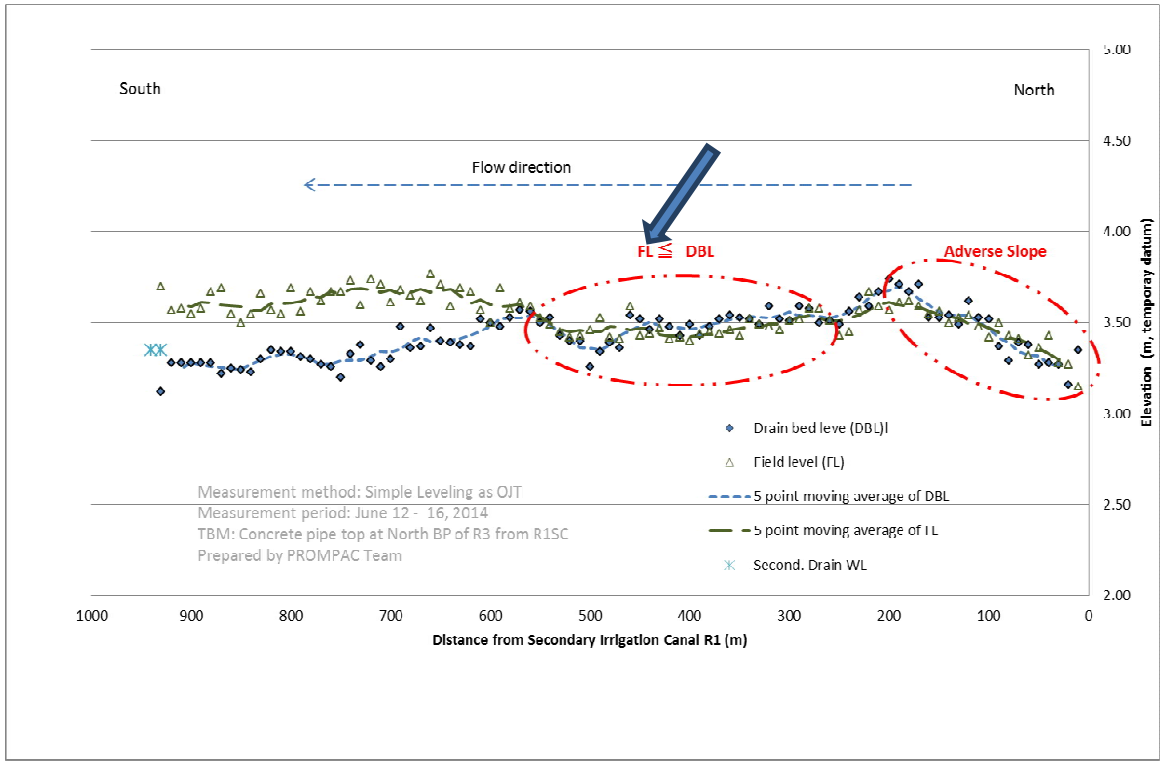


Figure 3.4: Profile of tertiary drain along R3TC in R1 area

Middle reach of above profile shows FL ≦ CBL. In this case, smooth drainage of excess water from field to drainage canal is quite difficult.

In case that farm road exists between rice fields and tertiary drainage canal, road crossing pipe culvert is often useful. Several examples are presented below.

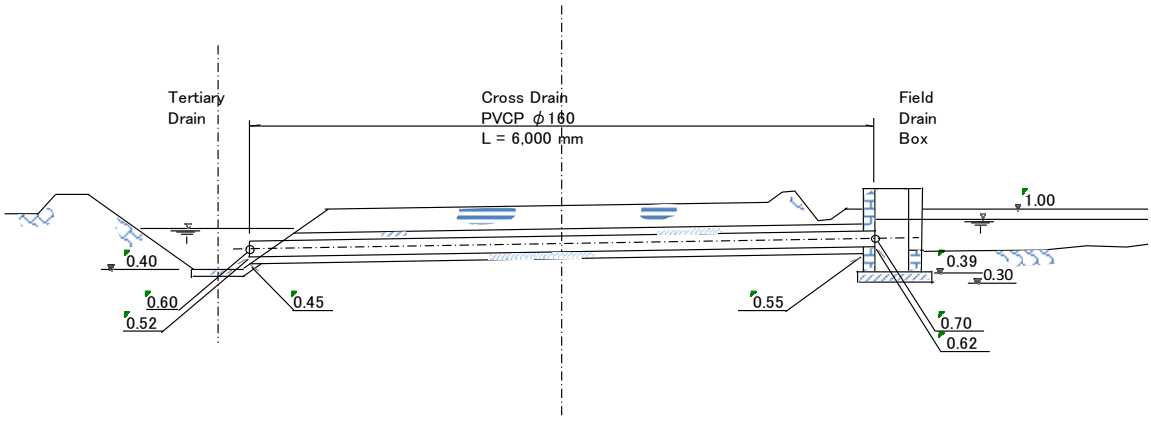


Figure Profile of Proposed Cross Drain in OJT in 2013

Figure 3.5: Road crossing pipe culvert

Photos 3.4 (1) Drainage improvement works including pipe culverts

Photos 3.4 (2): Drainage improvement works including pipe culverts

2.3.2. Profile of tertiary drainage canal

In the same profile in Figure 3.4, upper or northern part of the drainage canal has reverse slope, namely downstream bed level is higher than upstream one. Complete drainage is difficult from the northern depressed fields.

The following profiles suggest issues and countermeasures.

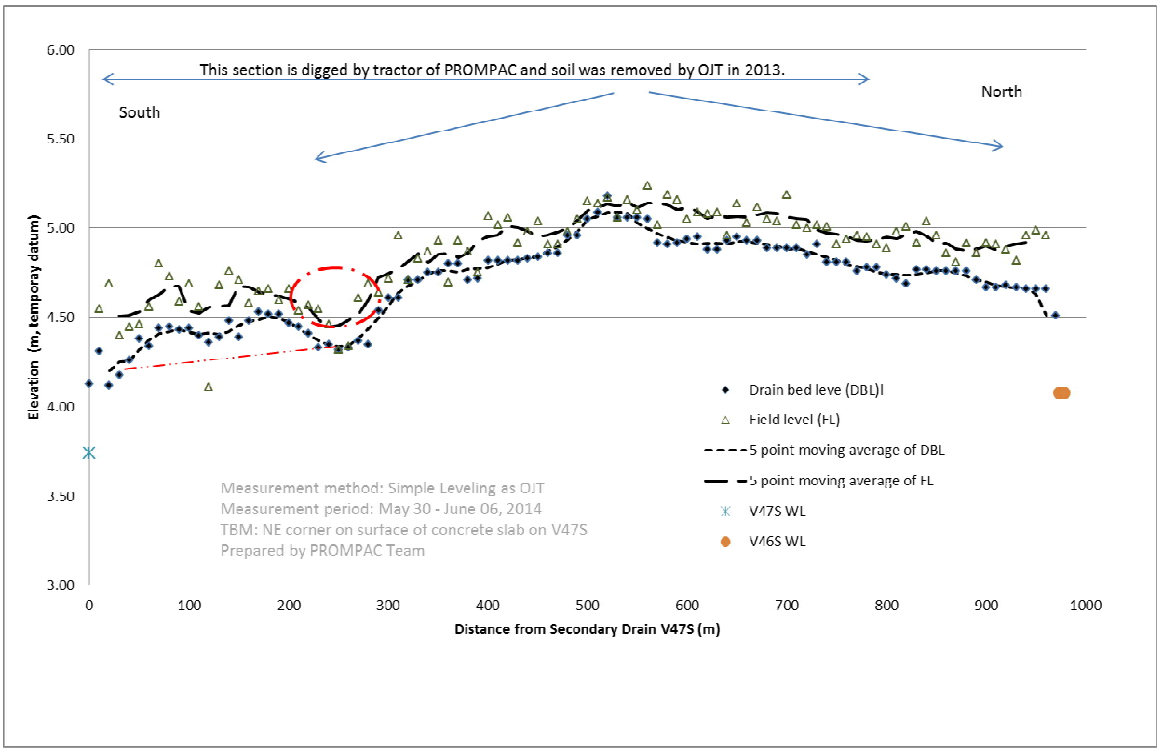


Figure 3.6: Profile of tertiary drainage canal along Ramal 7 in D12 area

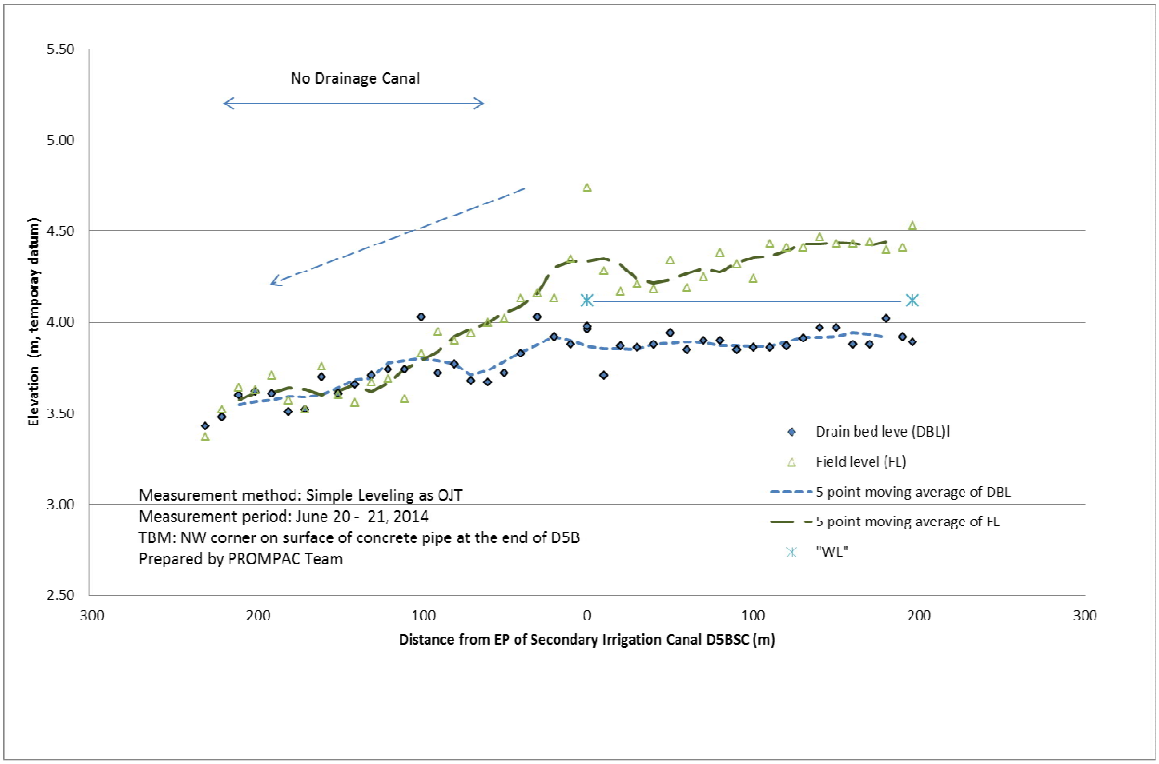


Figure 3.7: Profile of Tertiary Drain and its candidate route in D5B area

2.4. Drainage in field block or field lot (Ramal or cantera)

Quaternary drainage canal or temporary field drain may be effective in many field blocks.
In figure below, difference of the highest and lowest ground levels is 0.40 m. The ramal are divided

into canteras for rice cropping in such condition. In R3 area some parts are eroded and lowered, and other parts are filled with sediment and heighted by the flood in 2013. To improve this undulation, move of soil is desirable.

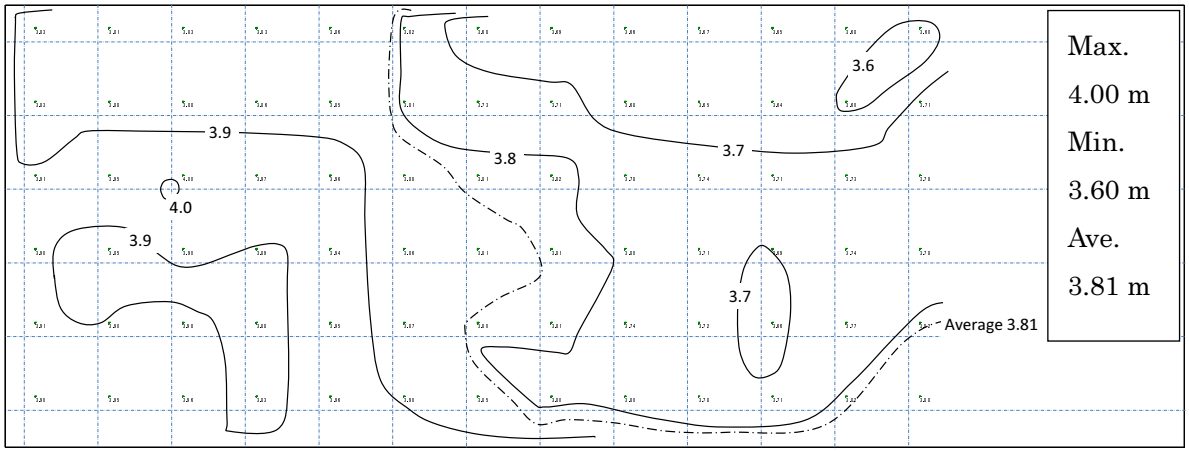


Figure 3.8: R3 area contour map

3. Simple Leveling

3.1. Purpose

Simple leveling is usable to know elevation difference (Δ) or ground level gap in rice field and between rice field and drainage canal bed. It can also be applied to prepare profile or longitudinal section of canal.

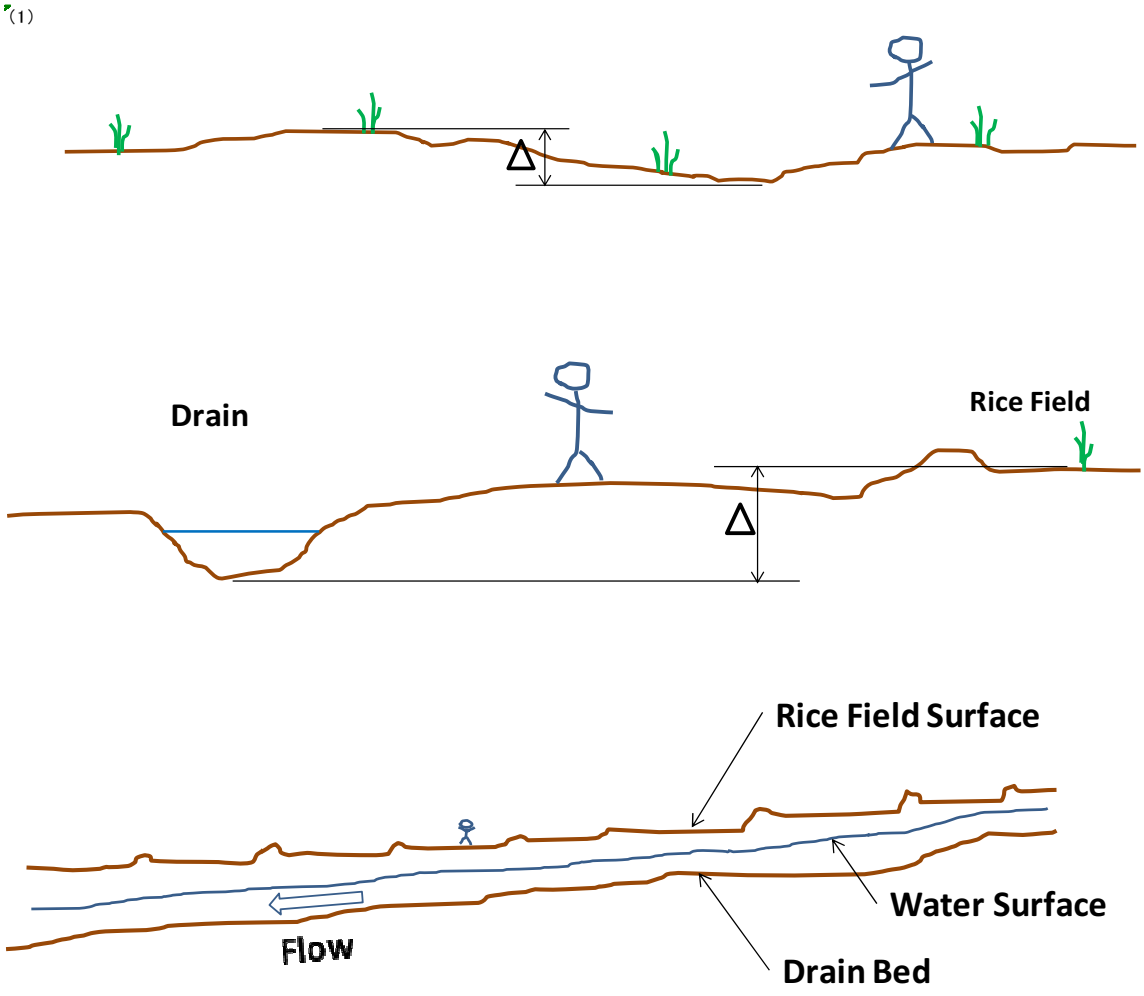
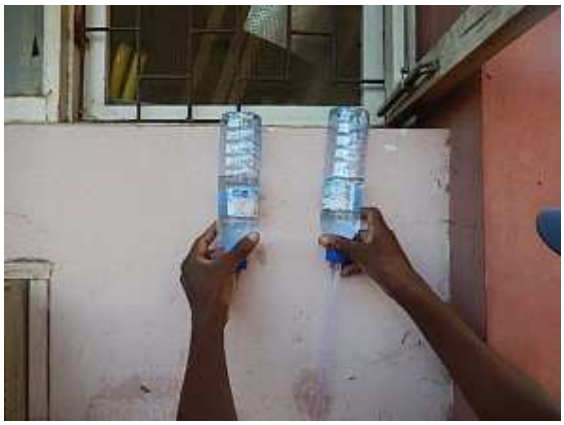


Figure 3.9: Main target of Simple Leveling

3.2. Tool and cost

(a) Flexible tube D=6mm L=5m



(b) Visible bottle (used)

(c) Simple scale L=2.5 m

(d) Water, tape, stake, etc.

Photos 3.5: Simple and low cost tools for simple leveling

Tools were prepared in Chokwe, using available materials in Chokwe.

(a) Flexible tube

Transparent plastic tube of 6 mm diameter was used. The tube of D=10 mm is also available, but the former was found better with less air mixture. Gas pipe was purchased and tried, but was not selected, because inside water and air cannot be seen, it is heavier to hold, and it is more expensive.

(b) Visible bottle

Used PET bottles of 0.5 liter were selected. Those of 1.5 liter were tried and found larger and heavier with water to carry. They were corrugated bottles, but plain bottles may be easier to see water level.

(c) Simple scale

Plastic light bars were used as simple scale with manually marked every 1 cm readings by oily ink pens (for example, red: 10cm, blue: 5cm and black:1cm). They are not strong and required to be treated carefully. Any other similar bars are usable.

(d) Water, tape, stake, etc.

Water can be contained and transported in the PET bottles.

Measurement tape or rope with a fixed length was employed for the profile survey of tertiary drainage canal and spot survey with mesh on rice field. Both 50m measurement tape and a 10 (ten) m rope were prepared. Combination of 10 m rope and 5 m convex is useful, practical and cheaper.

Stakes were used for spot survey on rice field to show mesh lines.

To connect two tubes, short tube with a little larger or smaller diameter was used as a joint. The joint was protected by vinyl tape for water tightness.

To connect tube and PET bottle, a hole was made in the center of cap of the bottle. The tube end was inserted through the hole, and then it was fixed with glue for water tightness.

(e) Cost estimate

Required cost for a set in Chokwe is estimated as follows.

Table 3.1: Cost estimate for a set of simple leveling

Material item	Spec./size	Quantity	Unit	Unit Price (MT)	Amount (MT)
Flexible transparent plastic tube	D 6mm, L=5m	3	piece	180	540
PET bottle	0.5 liter, used	2	bottle	0	0
Bar for scale	L=2.5 m	3	bar	100	300
Oily color pen	Red, blue & black	1	set-hour	5	5
PET bottle	1.5 liter, used	3	bottle	0	0
convex	5 m	1	no.	100	100
rope	10 m	1	no.	5	5
wooden stake	50 cm long	10	no.	5	50
Vinyl tape, glue & others		L.S.		50	50
Total					1050

(PROMPAC, Consultant Team)

Estimated total cost of 1,050 MT is not small amount for the farmers, but is much lower than the topographic survey equipment.

To measure drainage canal bed elevation at 10 m pitch, length of the flexible tube was decided at 15 m. If shorter tube length is sufficient, the tube cost can be reduced. If simple staff is made using abandoned wooden bar, the cost may be 0.

3.3. Basic consideration

3.3.1. Temporary Bench Mark (TBM)

Elevation (EL) difference is measured by simple leveling. However, absolute elevation based on some authorized datum such as mean sea level, is not measured when there is no authorized bench mark (BM).

In CIS, on farm level simple leveling is usually conducted without BM near the site. In this case, temporary BM (TBM) is selected to get relative elevation. Roughly speaking, ground elevation in CIS is mostly from 20 to 40 meters above mean sea level (mamsl) according to information from Google Earth.

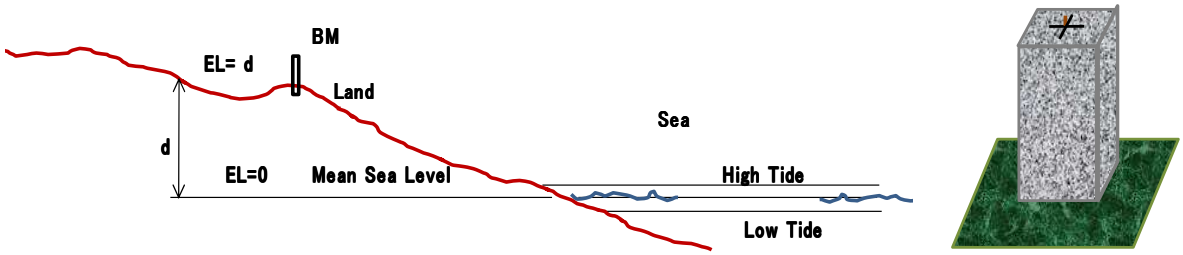


Figure 3.10: Elevation (EL) in “masl” and bench mark (BM) example

TBM is usually placed at stable and easily recognized position, such as concrete structure, metal surface and so on. Some of the TBMs selected in OJT simple leveling in 2014 in PROMPAC can be seen in photographs below.
Temporary elevation of TBM is set 5.00 m in OJT leveling in 2014.

Photos 3.6: Examples of TBM

3.3.2. Plan, profile and cross section

Measurement results are expressed as plan (Figure 3.8), profile (Figures 3.3, 4, 6 and 7) and cross section to understand the condition easily.

3.4. Measurement and record

3.4.1. Measurement

Measurement can be done as photos below.

Photos 3.7: Simple Leveling as OJT in June 2014

Difference of elevation (Δ) is measured as illustrated below.

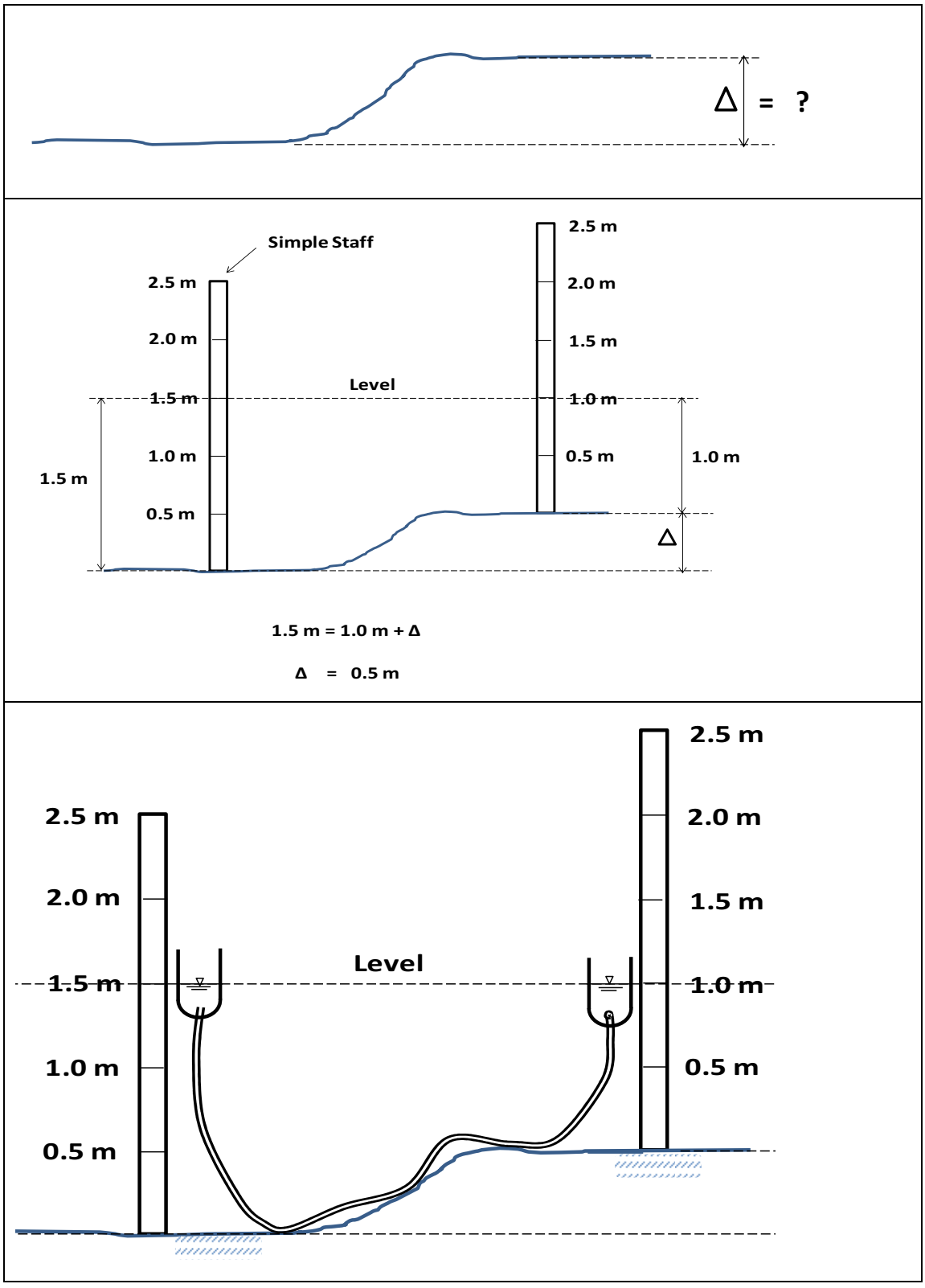


Figure 3.11: Simple Leveling in use of simple level and simple staff

In above case, Δ= difference of staff readings = 1.50 – 1.00 = 0.50 m.

Through trial and error method, it is decided that one bottle should be fixed at constant height for quicker measurement. For profile leveling, water level is kept at1.50 m in general at base point. The base point is such point that already EL can be known by calculation. Next point is such point of which EL is to be measured based on the base point EL. Distance between the points are decided 10 m in the OJT.

It needs certain time before water levels of two bottles become equal. Adjustment of height of the bottles is required at the both points for time saving.

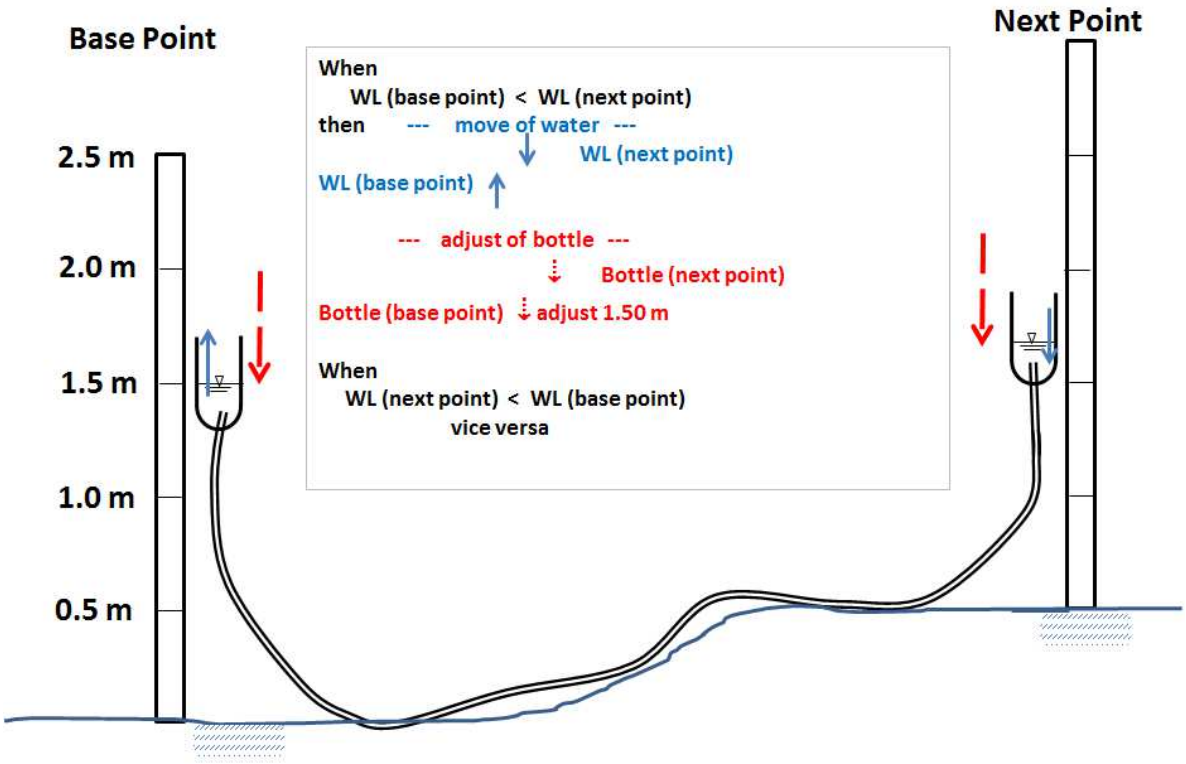


Figure 3.12: Adjustment of the bottle heights for water to be leveled

3.4.2. Basic cares

Before measurement

- Check should be done whether all the necessary tools and recording sheets are prepared or not. If not, lack of tool should be supplemented.

Treatment of the tools

- The tools should be treated gently, since they are fragile.
- The tube should not be trampled.

Water filling to the tube

- Water should be supplied gently from one of the bottles to avoid air mixture in the tube as much as possible.
- Air bubbles in the tube should be removed as much as possible. Water supply from another bottle may be effective to send out air bubbles.
- Before measurement, it should be confirmed that water level in both bottles move up or down according to the difference of water levels.

Simple staff setting

- Location of next point should be appropriately selected, namely at representative height in the rice field, bottom of tertiary drainage canal, and so on.
- After placed, the staff must keep the same level, even though it is turned.
- The staff must be kept without receiving outer pressure. Staff holder must not lean against the staff not to sink it down to soft soil.
- The staff should stand straight and vertical.
- The staff should stand properly but not upside-down.

Reading water level

- Next point bottle should start at expected height to save time. The expected height can be obtained by checking by eye, trend, and so on.
- Water level should be read from horizontal direction, but not upward nor downward.
- Before reading, water level stability must be carefully monitored. Observers must wait at least 20-30 seconds to judge WL is stable or not.
- In water level reading, careless mistakes must be avoided. Two or more observers should read the same water level.

After the measurement

- Contained water in tube should be drained slowly and gently through one of the bottles. Flow direction should be constant to avoid remaining water in fragments in tube as much as possible.
- The tube should be circularized smoothly without tube twist.

3.4.3. Recording

Table 3.2 is selected and employed sheet after trial and error.

A top dark shaded cell is for tentative elevation of TBM. Shaded cells are filled with measured values at site. Blank cells are filled through calculation.

In the column of remarks, notes should be written. The notes include TBM with its structure, drain filled with straw, undulating field just after ploughing with point location, unseen drain, soil bund, and so on.

Table 3.2: Simple Leveling Record Sheet

Simple Leveling Record Sheet

Place: Recorder:
Date/Time: Recorder:

No.	Accumulated Distance (m)	Base Point on drain bed		Next Point on drain bed		Next Point on field		Remarks
		H (m)	WL (m)	H (m)	EL (m)	H (m)	EL (m)	
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
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prepared by PROMPAC Consultant Team

Table 3.3: Sample recorded and calculated sheet for simple leveling

Simple Leveling Record Sheet

Place: R1, along and east of R3TC — Recorder: Calvin
Date/Time: June 12–16, 2014 — Recorder: Kurauchi

No.	Accumulated Distance (m)	Base Point on drain bed H (m)	Base Point on drain bed WL (m)	Next Point on drain bed H (m)	Next Point on drain bed EL (m)	Next Point on field H (m)	Next Point on field EL (m)	Remarks
0	*0*	② *0.50*	③ 5.50		① **5.00**			**TBM**
1	*10*	⑥ *1.00*	⑦ 4.80	④ *1.70*	⑤ 3.80			Irrigation C.
2	*10*	⑫ *1.50*	⑬ 4.85	⑧ *1.45*	⑨ 3.35	⑩ *1.65*	⑪ 3.15	
3	*20*	⑯ *1.50*	⑰ 4.66	⑭ *1.69*	⑮ 3.16	⑱ *1.39*	⑲ 3.27	
4	*30*	*1.50*	4.77	*1.39*	3.27	*1.49*	3.28	
5	*40*	*1.50*	4.78	*1.49*	3.28	*1.35*	3.43	
6	*50*	<b> *1.50*	<c> 4.77	*1.51*	<a> 3.27	*1.41*	3.36	
7	*60*	(i) *1.50*	(ii) 4.88	<d> *1.39*	<e> 3.38	(iii) *1.56*	(iv) 3.32	
8	*70*	*1.50*	4.89	*1.49*	3.39	*1.48*	3.41	
9	*80*	*1.50*	4.79	*1.60*	3.29	*1.36*	3.43	
10	*90*	*1.50*	4.87	*1.42*	3.37	*1.37*	3.50	
11	*100*	*1.50*	5.02	*1.35*	3.52	*1.60*	3.42	
12								
13								

3.4.4. Calculation

A cycle of the calculation is as shown below.

<a> Firstly, known ELa is the starting point as base point, either EL of TBM or drainage canal bed level. (3.27 m in Table 3.3)

<b> Water level is kept at 1.50 m or some other constant height.

<c> WL = ELa +1.50 at base point (3.27 + 1.50 =4.77)

<d> At next point with usual distance of 10 m, water level is adjusted to stable condition and staff height is read Hd. (1.39 m)

<e> WL – Hd = ELe (4.77 – 1.39 = 3.38 m)

3.5. Results

3.5.1. D5 Area

Simple leveling was carried out along R20 of D5 Secondary Irrigation Canal (SC) and along rectangular route to D5B-SC as shown in Figure 3.13.

Profile of former case is illustrated in Figure 3.14. Difference of west side field level and bed level of tertiary drainage canal (partly filled with soil or cannot be seen) or its route is little and insufficient. For drainage improvement, three options may be considered. One is construction and deepening of tertiary drain. Another is construction of road crossing pipe culverts from field to the secondary drain. The third is combination of the first and second methods.

Anyway, it is necessary to study drainage system in the area up to Primary Drainage Canal No.2 (Vala II) for study of the countermeasures.

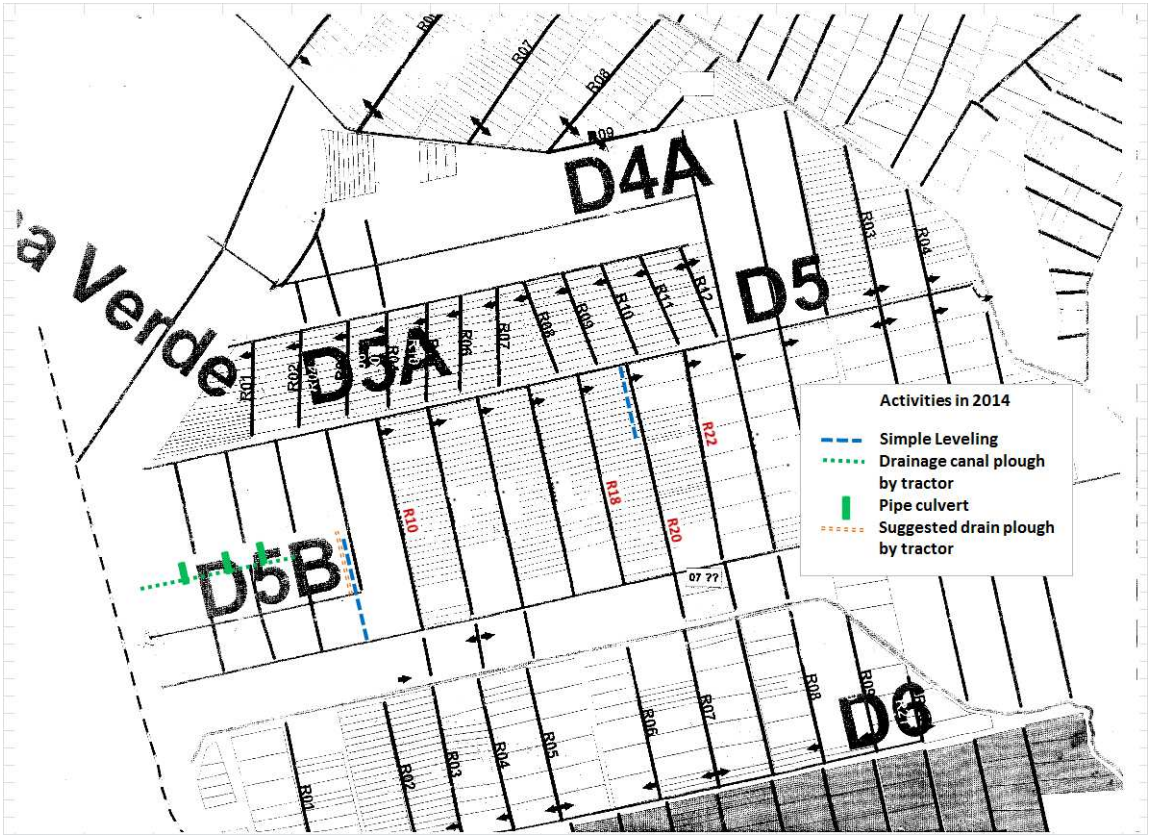


Figure 3.13: Simple Leveling and drainage improvement works in D5 area in 2014

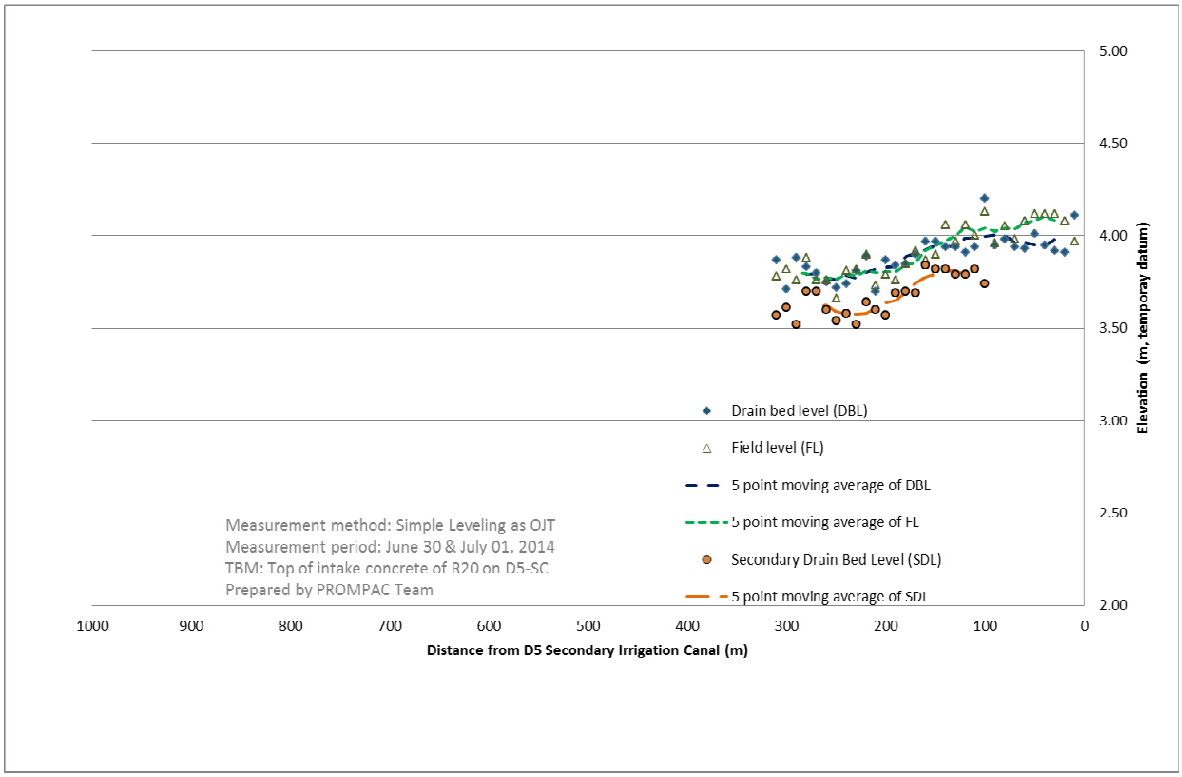


Figure 3.14: Profile of Route of Tertiary Drainage Canal along R20 TC in D5 area

On the latter case in D5B area, profile is presented in Figure 3.7 in above 2 (3) (b). As seen in following photos, drainage condition is poor at place to place. Based on exchange of ideas with farmers' group, the tertiary drainage canal (actually used as dual purpose canal) was ploughed by a tractor as illustrated in Figure 3.13. In addition, three pipe culverts were constructed for easy irrigation and drainage water flows.

WL field ≒ WL drain (May 15)

No water on field : Water in drain (June 20)

Photos 3.8: Drainage condition before and after harvest in D5B area

If farmers wish to drain stagnant water after harvest, tertiary drainage canal should be dug by tractor to northern direction in parallel with original tertiary irrigation canal of caleiras. By that, drainage condition during rice cropping also expected to be better.
If farmers sometimes want to store water in the drainage canal, simple gate should be provided or farmers may control by soil or sand bags.

3.5.2. D6 area

Selected alignment is along R13 tertiary irrigation canal as in Figure 3.15. The tertiary drain is intermittent. Difference of field and drain bed is little or nearly zero. Since land slope is rather steep at around 1/250 as can be seen in Figure 3.16, drainage can be effective, if tertiary drainage canal be dug properly.
The drainage canal was one of the six tertiary drainage canals cleared and cleaned in 2012. At the downstream end, pipe culvert was constructed in 2012 to connect Main Drainage Canal No.2 (Vala II).

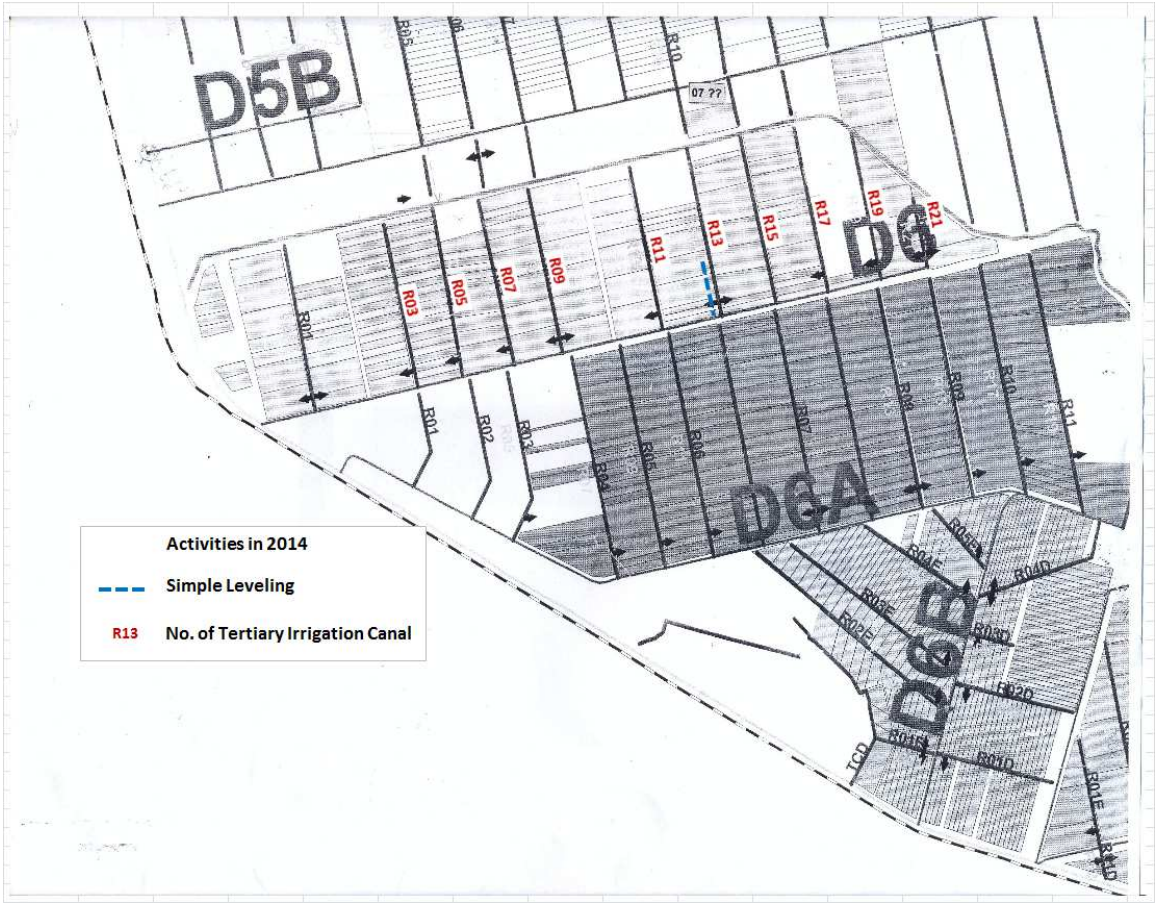


Figure 3.15: Simple Leveling in D6 area in 2014

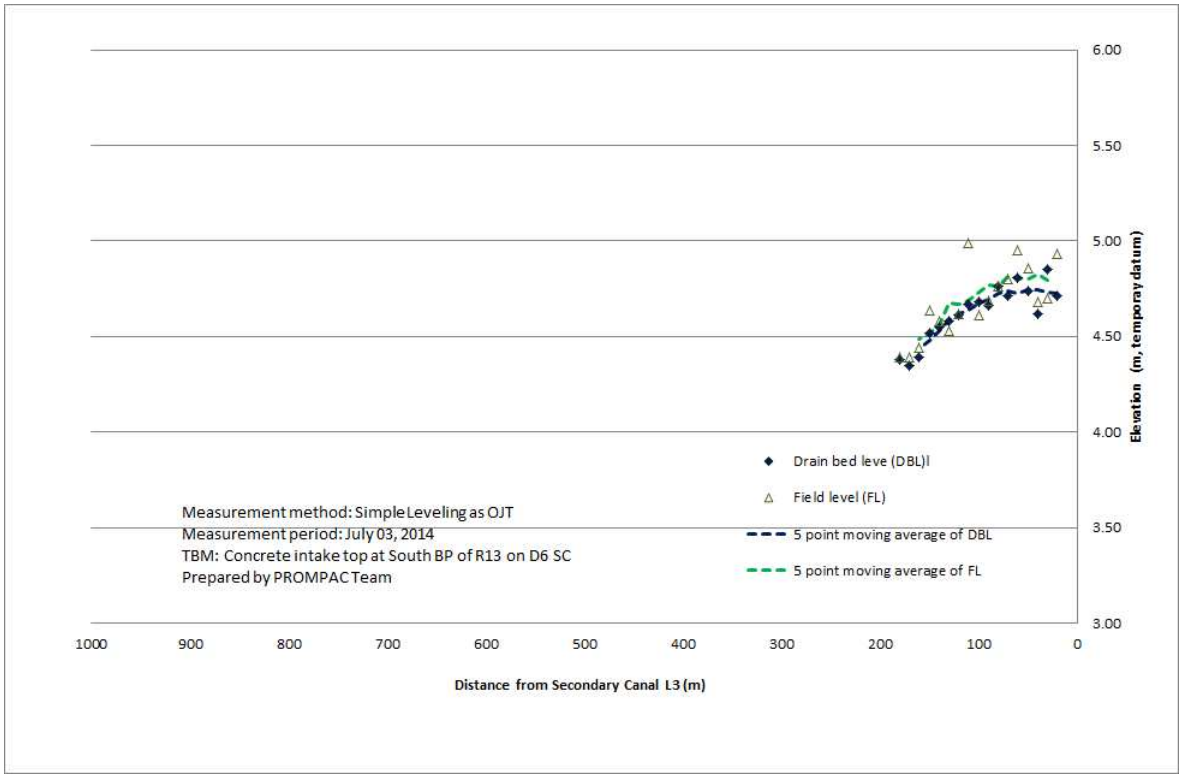


Figure 3.16: Profile of tertiary drainage canal route along R13 TC from D6 SC

3.5.3. D11 area

Simple leveling was performed along the tertiary drainage canal located east side of demonstration farms in 2012. The drain is between R16 and R18 tertiary irrigation canals as presented in figure below. Profile of the tertiary drainage canal is in Figure 3.3.

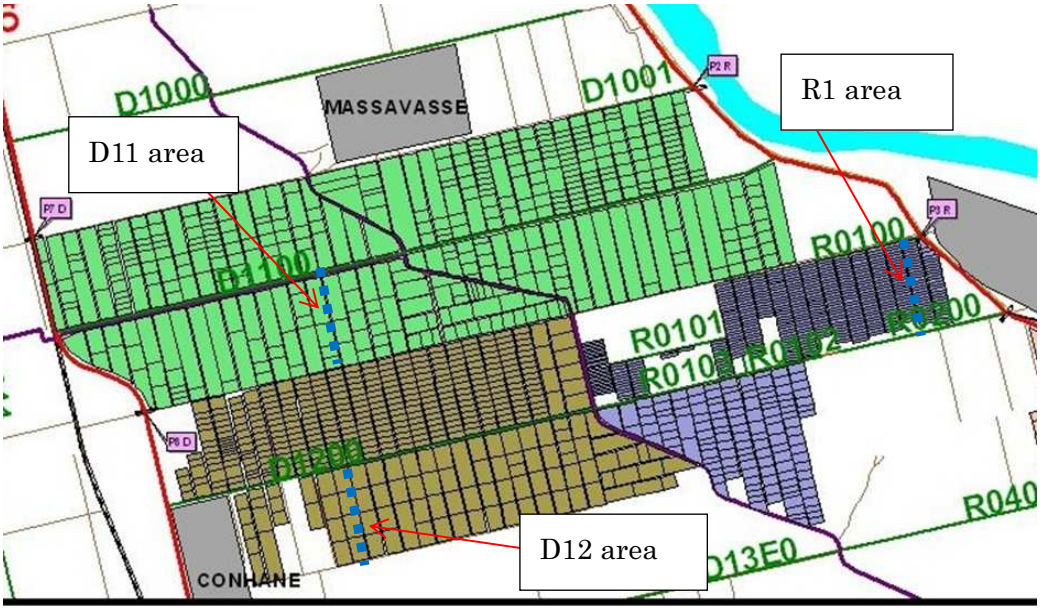


Figure 3.17: Simple Leveling as OJT in 2014 in D11, D12 and R1 areas

3.5.4. D12 area

Location of simple leveling is as shown in Figure 3.17. The profile is seen in Figure 3.6.
As farmers talk, there is a slight but clear peak in the middle.

3.5.5. R1 area

Location is illustrated in Figure 3.17. The profile is presented in Figure 3.4. Tertiary drainage canals were constructed recently as a portion of rehabilitation project. The drainage canal does not function well and sometimes flood water comes from downstream.
Causes of such problems can be understood by the profile.

3.5.6. R3 area

It is informed that tertiary drainage canal is well functional but flood in 2013 eroded a part of field and sedimented on another part. In a field lot, level gap is large and undulation occurred. Therefore, profile of the drain is made only for short distance and spot leveling was conducted in a field lot. The contour map is in Figure 3.8.

3.6. Countermeasures

Recommendable countermeasures for each area are summarized below.

Table 3.4: Problem and countermeasure

Area	Problem	Countermeasure
D5 R20	Poor drainage	Survey of secondary drain and check of the system
D5B	Poor drainage/irrigation water	Dig tertiary drain by tractor and manpower
D6	Poor drainage against heavy rainfall	Dig tertiary drain by livestock and manpower
D11	Stagnant water ponding	Prepare profile of secondary drain and try to lower its water level
D12	Depression in the middle of ramal	Excavate drain bed downstream of the depressed portion
R1	Poor drainage and back water intrusion from downstream secondary drain	Survey of SD and its system Excavate drain bed Change depressed field to fish pond Heighten low field by excavated soil
R3	Large level gap in ramal	Cut soil in higher part and move it to lower part

Appendix

1. Fabrication of Manual seeder

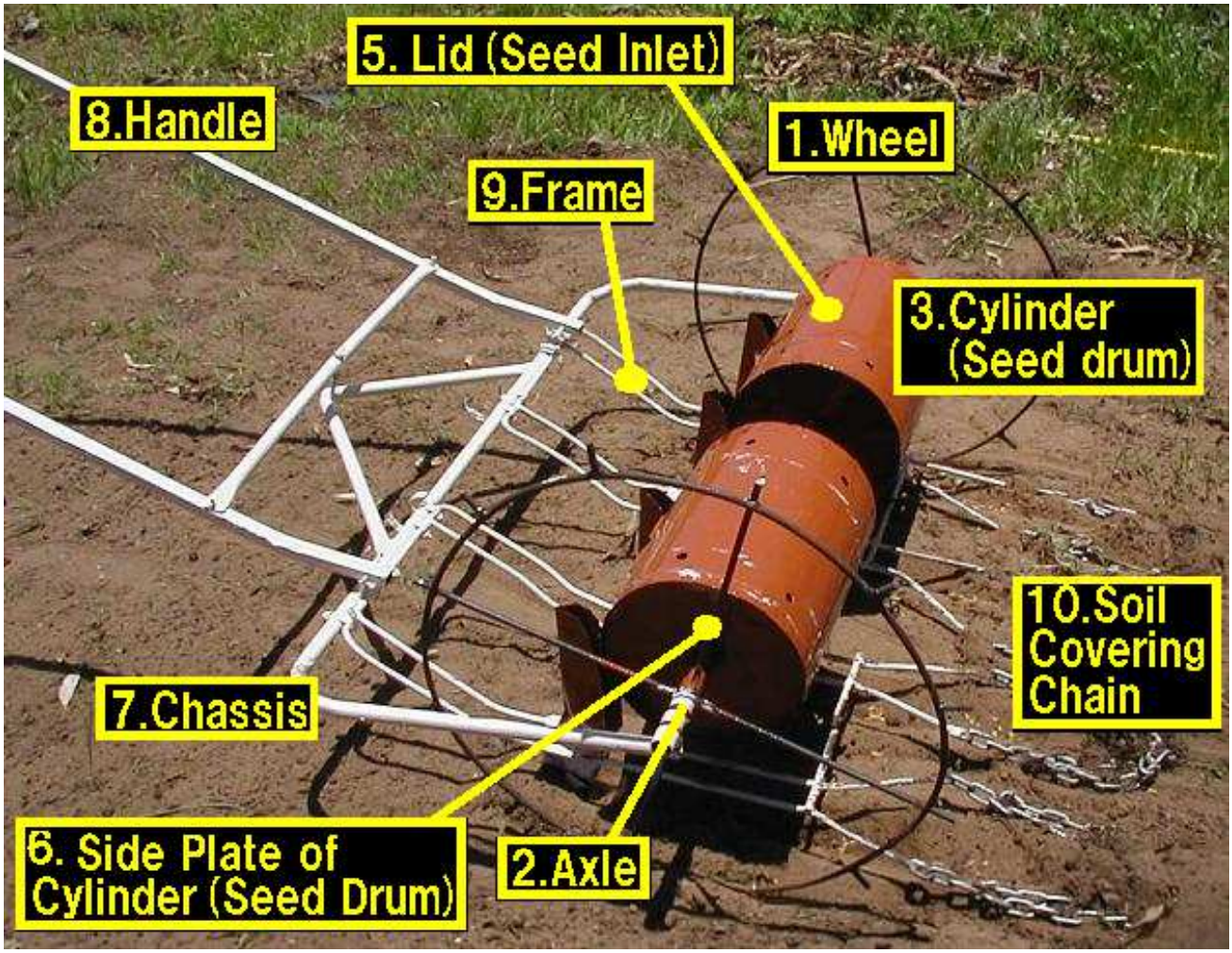
2. The management of farmers' group (Examples of book keeping)

Fabrication Manual for Man-Power Drawn 4-Row Paddy Seeder (Bran)

Contents

No.	Item	Page
	Overview of Row Seeder	
	List of Parts	
	List of Required Tools	
1	Wheel	
2	Axle	
3	Cylinder (seed drum)	
4	Seed Flow Control Plate	
5	Lid (seed inlet)	
6	Side Plate for the Cylinder (seed drum)	
7	Chassis	
8	Handle	
9	Frame	
10	Soil Covering Chain	
11	Painting, Adjustment for Seed Outlet	

【Overview of Row Seeder】

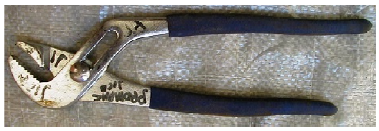


※ The "4. Seed Flow Control Plate" is installed inside of the "3.Cylinder (Seed drum)," so it is not shown this image

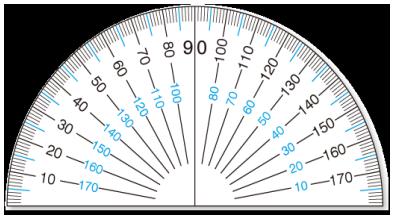
【List of Parts for Man-power Drawn 4-Row Paddy Seeder】

No.	Name	Specification (mm)	Unit Price (Mt.)	Q'ty (1 seeder)	Price (Mt./seeder)	Required for
1	Round Steel Pipe	internal diameter 17、external d	675	1250mm	141	2. Axle
2	Round Steel Pipe	internal diameter 22、external diameter 26、length 6000	900	3570mm	536	1. Wheel (Hub), 7. Chassis、8. Handle
3	Square Steel Pipe	20 X 20、length 6000	275	3000mm	138	8. Handle
4	Round PVC Pipe	internal diameter 22、external d	195	240mm	8	2. Axle
5	Reinforcing Bar	external diameter 6、length 60	100	200mm	3	7. Chassis
6	Reinforcing Bar	external diameter 10, 6000	152	14586mm	370	1. Wheel, 9. Frame
7	Metal Sheet	1000 X 2000, 0.4 thick	968	1.03 sq m	499	3. Cylinder (seed drum)
8	Metal Sheet	1000 X 2000, 1.5 thick	1000	0.15 sq m	75	3. Cylinder (seed drum) 9. Frame (furrow cutting plate)
9	Hose Band	around ϕ30	40	12	480	7. Chassis & 9. Frame attachment, 2. Axle & 3. Cylinder (seed drum) attachment
10	Aluminum Rivet	ϕ3.2 X 13 (50/bag)	75	About 100	150	3. Cylinder (seed drum)
11	Hinge	There should be a distance of a	30	4	120	3. Cylinder (seed drum)
12	Hexagonal Bolt	M6X30	100	2	200	8. Handle
13	Hexagonal Nut	M6	30	2	60	8. Handle
14	Hexagonal Bolt	M8X50	100	1	100	7. Chassis
15	Hexagonal Nut	M8	30	2	60	7. Chassis
16	Steel Chain	ϕ8	150/m	4000mm	600	10. Soil Covering Chain
17	Wire	around Φ2.0	10/m	Approximately 3m	30	10. Soil Covering Chain
18	Paint (Oil Base)	White(500ml/can)	280	1	280	7. Chassis, 8. Handle, 9. Frame, etc.
19	Paint (Oil Base)	Brown(500ml/can)	280	1	280	3. Cylinder (seed drum)
20	Paint Thinner	500ml/can	200	1	200	For painting
21	Paint Brush	Large	220	1	220	For painting
22	Paint Brush	Small	220	1	220	For painting
Total (costs of parts)					4768	
Welding Fees					approximately 3000	
Grand Total					7768	

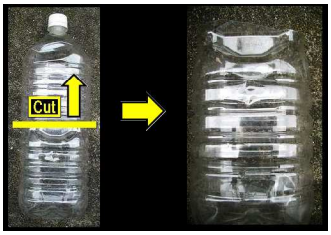
【List of Required Tools】

No.	Photo Image	Name	Remarks
1		Long-nose Pliers	For precision work, such as piercing a hole for the axle on the side of the seed drum as well as to connect the soil covering chain to other parts.
2		Vice-grip Pliers	For fixing together parts, when determining the bending places on the metal sheet of the seed drum as well as holding parts for welding, etc.
3		Water-pump Pliers	For holding large parts. The jaws of these pliers are adjustable.
4		Side cutting Pliers	For working on metal sheet. Used also to cut wires.
5		Metal Shears	For cutting the 0.4mm thick metal sheet of the seed drum.
6		Pipe Wrench	For holding round and square steel pipes, and used when bending.
7		Hacksaw	For cutting metal pipes as well as chain links. Be careful of the sharp blade.
8		Flat-head Screwdriver	For tightening a hose band, etc.
9		File (flat, round, square)	For filing rough edges of metal sheet, metal pipes and PVC pipes. Handle with care, it is easy to break or blunt the file.
10		Hammer	For hammering metal sheet of the seed drum or flattening the head of rivets etc.
11		Chisel	For marking the bending points when making the seed flow controle plate, handles, etc.
12		Centerpunch	For punching metal sheet to decide drill position.
13		Riveter Aluminum Rivet= ϕ3.2 X 13	For riveting metal sheet to fix each side. Use the appropriate size of nose piece for the rivet size.

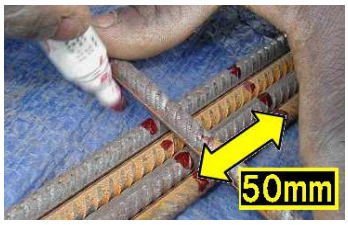
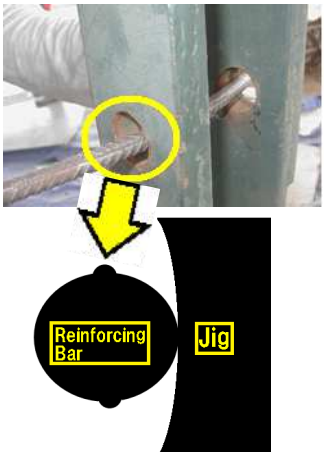
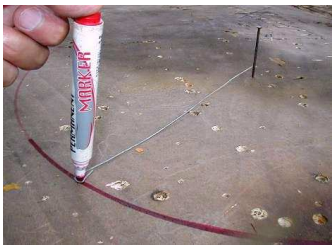
【List of Required Tools】

No.	Photo Image	Name	Remarks
14		Tape Measure	For measuring length.
15		Ruler	For measuring the length and drawing the plan for rivet, etc.
16		Vernier Calipers	For measuring the length in minutes (inner or outer diameter of round steel pipes and thickness of the metal sheet).
17		Protractor	For measuring bending angles.
18		Marker	For drawing cutting lines as well as bending lines and marking other places.
19		Bench vice	For holding materials such as when making the furrow sheet as well as when bending the materials to make the frame, etc.
20		Reamer (size here is Φ4～22mm)	For expanding the diameter of a hole, when no larger diameter of a drill is available.
21	 	Electric Drill & Drill bit for metal= 3,4,7,9mm	For drilling to pierce a hole. Unplug the drill when the drill bit is being changed. Be careful not to lose or misplace the chuck for the drill. (This is the part indicated by the yellow box in the picture on the left.)
22	  	Electric Grinder Cutting Disk Grinding Disk	For cutting or grinding. Unplug the grinder when the disc is being changed. Be careful not to lose or misplace the wheel nut spanner. (This is the part indicated by the yellow box in the picture on the left.)

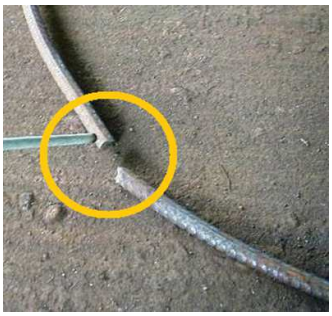
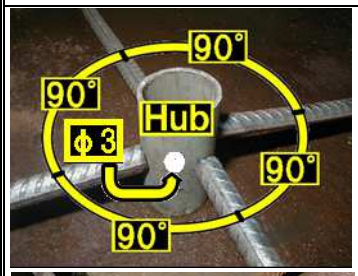
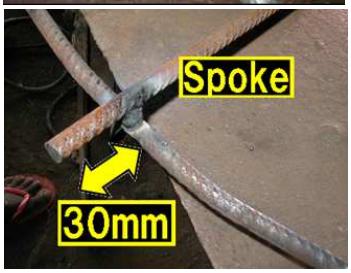
【List of Required Tools】

No.	Photo Image	Name	Remarks
23		Extention cable drum (50m)	For use with the electric drill and grinder. Uncoil completely when using as there is a fire hazard caused by the heated coil of the electric wire.
24	 	Paint & Brush	Shake the paint can well before use. Mix through the paint from the bottom of the can with a clean stick, after opening the lid. Avoid using tree branches since it may contaminate the color of the paint. Used brushes should be washed thoroughly, using the paint thinner and dried.
25		Paint Thinner	For diluting the paint as well as washing off the paint from the paint brush. Keep fire sources away, since it is highly flammable. Tighten the cap firmly after use.
26		Empty PET Bottle	For rinsing paint brushes after use.
27		Lubricant	For lubricating frictional parts, such as axle, etc.
28		Scales (approximately 1kg Mx.)	For weighing the appropriate volume of seed for the row seeder.
29		Bowl, plate, etc.	For containing and weighing the appropriate volume of seed for the row seeder.
30		Bluesheet	For spreading to catch seeds when weighing the appropriate volume of seed for the row seeder.

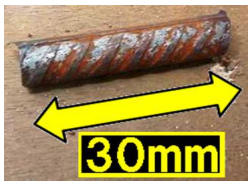
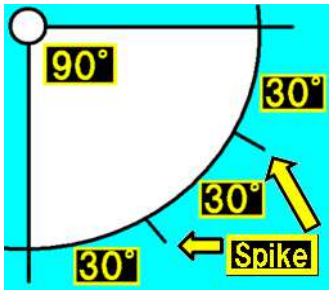
1. Wheel

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		●Manufacturing process for the wheel ①Cut the reinforced steel bars. ②Mark the points where the reinforced bars should be bent. There should be a distance of 50mm between these marked points.	●Reinforcing bars length=1885 diameter=10	●Electric grinder (cutting disk), or hacksaw ●Marker pen	●2
2	 	①Reinforcing bars should go into the holes of the jig and be bent at each of the marks, in order to make a circle of 600mm diameter. ※The ridges on the reinforcing bars should be facing upward and downward while each bend is made.(Otherwise, the accuracy of overall form may be impaired.)	●Diameter=600	●Jig (The coupling mechanism of a tractor that is no longer in use can be utilized for this purpose.)	●2
3	 	①Draw a circle (600mm radius) on a plywood sheet. ※Refer to "6. Cylinder (seed drum) Side -1." ②Place the bent circular form on to the drawing, and adjust using the pipe wrench, until the circular form matches exactly with the drawing and everything lies flat on the plywood sheet.	●Diameter=600	●Pipe wrench ●Marker pen ●Wire ●Nail	●2

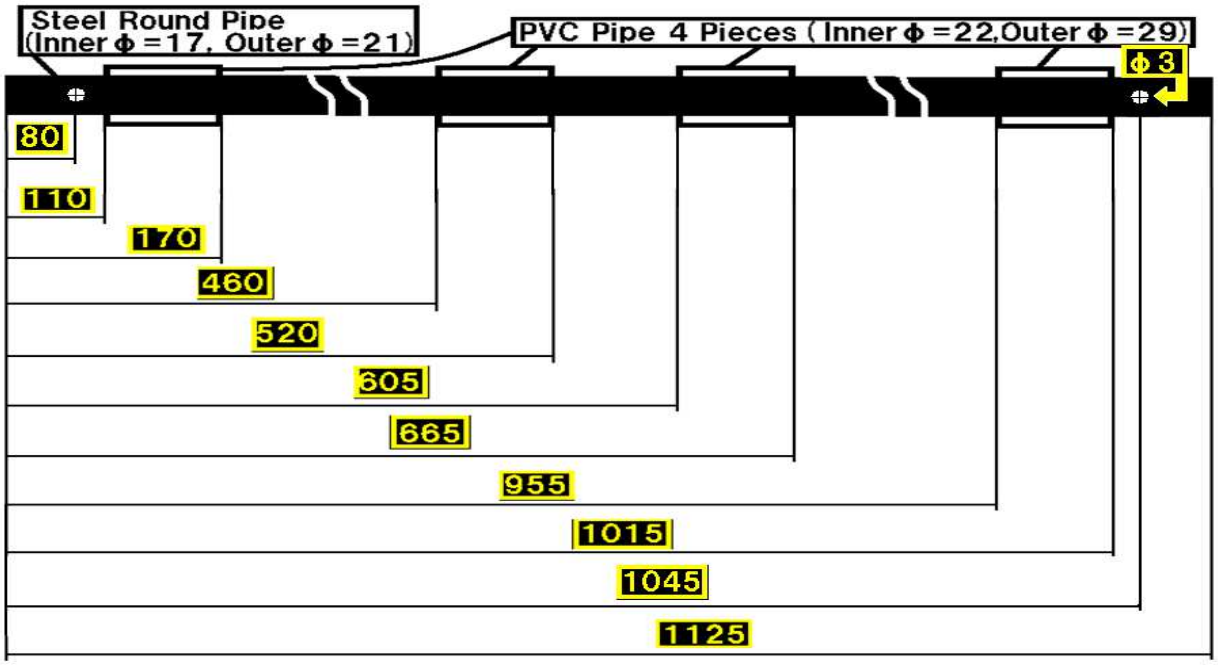
1. Wheel

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
4	 	①Weld the ends of the reinforcing bars together to complete the circle.	●Diameter=600	●Arc welder	●2
5		●Manufacturing process of the hub ①Cut the steel pipe. ②The holes used to connect the hub to the wheels should be made by drilling all way through the pipe on two occasions. The holes should be made in the center of the pipe and be perpendicular. (See picture)	●Round steel pipe length=50 internal diameter=22 external diameter=26 diameter of hole=3	●Electric grinder (cutting disk), or hacksaw ●Drill ●Drill bit for steel ϕ 3mm	●2
6	 	●Manufacturing process of the spokes ①Cut the reinforcing bar. ②Looking directly from the above, place the hub at the center of the circle. Place the four spokes at 90 degrees to each other. (See the top picture) ※The hub connection pin holes (ϕ 3) should be positioned in line with the spokes. (See the top picture) ③The outer end of each spoke should protrude 30mm beyond the circumfrence of the reinforced bar circle. (See the bottom picture) ④Weld ② and ③ togehter.	●Steel bar length=317 diameter=10	●Marker pen ●Electric grinder (cutting disk), or hacksaw ●Arc welder	●8 bars (4 bars / wheel)

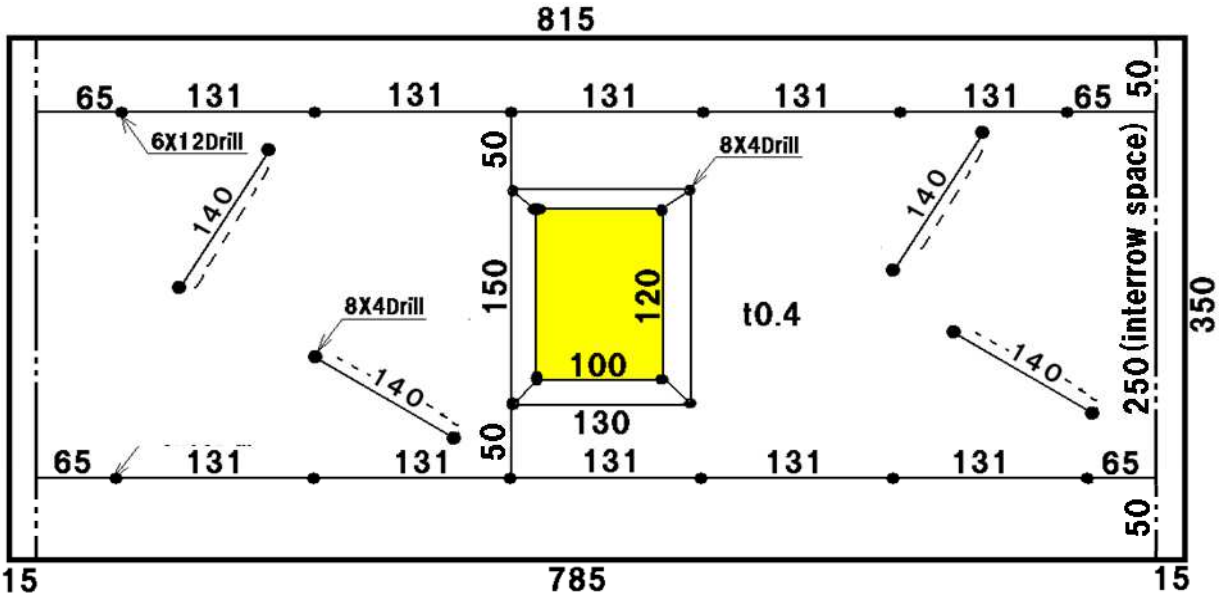
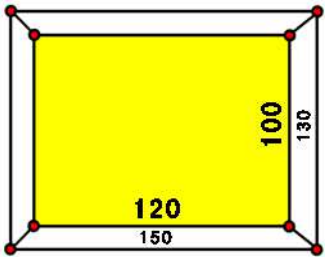
1. Wheel

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
7	  	●Manufacturing process of the spikes ①Cut the reinforcing bars. ②Place two spikes equidistantly between each of the spokes. (interval angle should be 30 degrees) ③Weld spikes to the wheel.	●Steel bar length=30 diameter=10	●Marker pen ●Electric grinder (cutting disk), or hacksawa ●Arc welder	●16 bars (8 bars / wheel)
8		Completed wheel	●Diameter=600		●2

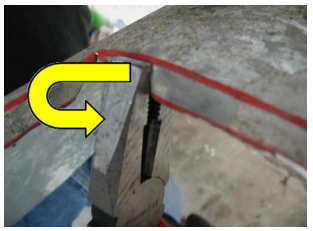
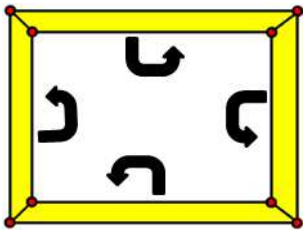
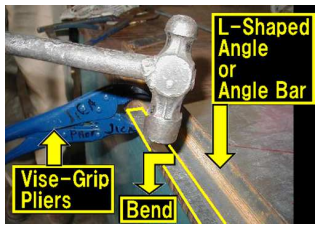
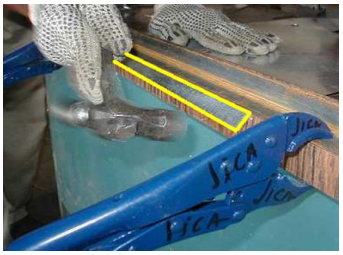
2. Axle

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1					
2		①Cut one round steel pipe. ②Cut four PVC pipes. ③Slide the PVC pipe(②) sections over the length of the round steel pipe. (see the figure 1) ④Make a 3mm hole, 80mm from each end of the round steel pipe.		●Ruler ●Electric grinder (cutting disk), or hacksaw ●Flat file ●Hammer ●Centerpunch ●Drill ●Drill bit for steel ϕ 3mm	●1

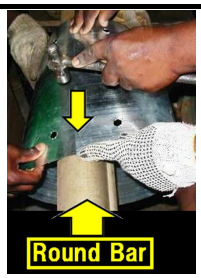
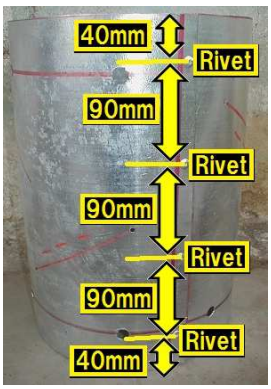
3. Cylinder (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1A	<See 1B.> ●The black dots (•) are the precise points to be centerpunched and then drilled. ●The 140mm diagnal line is the position for the "4. Seed flow control plate." •The positions of the holes for the seed flow control plate should be approximately as shown on the diagram 1B. (It does not have to be absolutely exact, as this will not adversely affect the flow of the seed.) •The fin should be positioned towards the side of the dotted line.	①It is possible to duplicate the positioning of all holes in the second sheet by placing the first sheet on top of the second sheet, and using the centerpunch to mark the holes on the second sheet.	●Steel plate 350 X 815 thickness=0.4	●Ruler (approx. 500mm) ●Marker pen ●Tape measure (3 m) ●Metal shears ●Centerpunch ●Hammer	●2
1B					
2	 	●Cut a section away for the doorway for the seed inlet. ①Mark eight points to create two rectangular areas, one inside (yellow part) the other, using either a centerpunch or a nail. These points should be positioned as according to the diagram. (The eight points are shown in the diagram on the left.) ②Drill a 4mm hole at each of these eight centerpunched positions. (Those eight points are the red points shown in the diagram on the left.) ③Cut the yellow rectangular section away (as shown on		●Metal shears ●Drill bit for steel ϕ 4mm ●Chisel ●Metal undersheet or thick steel plate ●Centerpunch or nail	●2 sections to be cut away (1 setion / sheet)

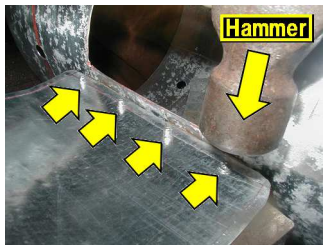
3. Cylinder (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
3	  	①The sections between internal and external rectangles should be bent back 180 degrees (as in the diagram on the left). ※The four sections are marked in the yellow in the diagram on the left.		●Pliers	●8 positions {4 positions/cylinder (seed drum)}
4	 	①After bending 180 degrees, the rim of the rectangle should be hammered flat all around.		●Hammer ●Metal undersheet, or thick steel plate	●8 positions{4 positions/cylinder (seed drum)}
5	   	●Bending the sheet into the cylinderical form. ①In order to create a cylinder, a folded lip should be created at each end of the rectangler plate. The lip is made by folding over a narrow strip at the shorter ends of the rectangle. Please refer to the pictures on the left.		●Hammer ●Bench vice ●L-shaped angle bar (approx. 1inch X 1inch)	●4 positions{2 positions/cylinder (seed drum)}

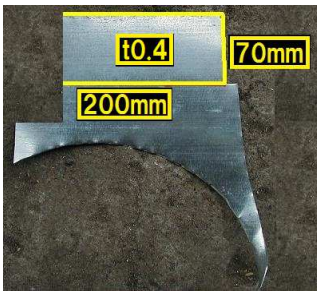
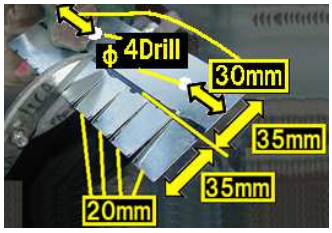
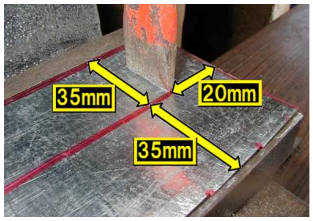
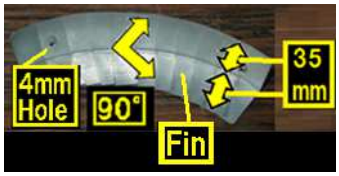
3. Cylinder (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
6		①The two folded ends of the rectangle should be connected accordingly and hammered together to secure the join. A round bar should be placed underneath the connecting section when hammering together.		●Hammer ●Round bar (approx. ϕ 100)	●2
7		①Centerpunch the points where holes should be drilled. ※Please refer to the picture 8. ②Drill the holes.		●Centerpunch ●Drill ●Drill bit for steel ϕ 4mm	●8 positions{ 4 positions/cylinder (seed drum)}
8	 	①Place the nose of the riveter against the cylinder, place a hand right underneath the pisition of the riveter, make sure there is no gap between the nose of the riveter and the metal plate and rivet at four indicated positions.	The locations and the distances between reveting points are as shown in the picture on the left. ●Rivet= ϕ 3.2 X 13	●Riveter	●8 rivets{ 4 rivets/cylinder(seed drum)}
9	 	●Installation of the hinges for the seed inlet door. ①Centerpunch the positions for the holes. ②Drill the holes at the centerpunched positions.		●Hammer ●Centerpunch ●Drill ●Drill bit for steel ϕ 4mm ●Wooden block	●8 holes{(4 holes/cylinder (seed drum)}

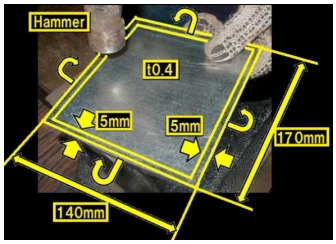
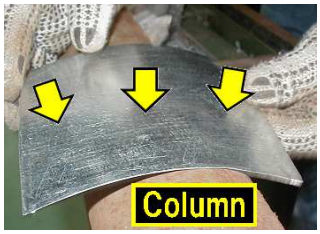
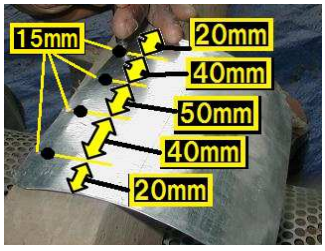
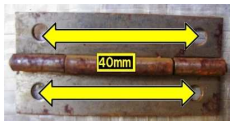
3. Cylinder (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
10		①Fix the hinge to the cylinder by rivetting.	●4 hinges(2 hinges/cylinder) ●Rivet= φ3.2 X 13	●Riveter	●8 rivets{(4 rivets/cylinder (seed drum)})
11	Refer to「5.Lid (for seed outlet)」				
12		①Fix the lid by rivetting.	●Rivet= φ3.2 X 13	●Riveter	●8 rivets{4 rivets/lid(for seed outlet)}
13		①Hammer flat any protruding part of the rivet on the backside of the lid, to enable the lid to close completely.		●Hammer ●Metal undersheet, or thick steel plate	●8 rivets{4 rivets/lid(for seed outlet)}

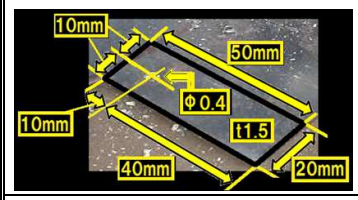
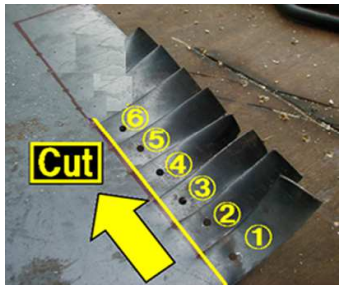
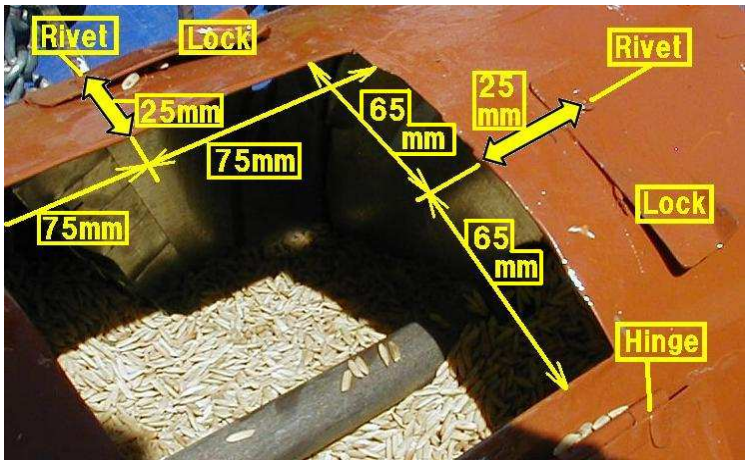
4. Seed Flow Control Plate

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		※ This part is rather small, so some cut away sections, like the ones leftover from the making of the cylinder, should be used to maximize the limited materials.	●Metal sheet=70 X 200 thickness=0.4	●Ruler ●Metal Shears	●8 sheets {4sheet/cylinder (seed drum) }
2		①Nine incisions are to be made to make ten fins on the seed flow control plate. ② Centerpunch two positions on the sheet of the seed flow control plate. ③ Drill two 4mm hinge holes.	●Size of a fin= 35 X 20	●Metal Shears ●Centerpunch ●Drill ●Drill bit for metals ϕ 4mm	●8 sheets {4 sheets/cylinder (seed drum) }
3		① Chisel the "seed flow control plate" gently on the extension line of incision to make it flexible and to fit the inner surface of the cylinder (seed drum). ※Pay attention not to cut off the fins by chiseling too hard.	●Size of bend = 35 X 20	●Chisel ●Hammer ●Metal undersheet or thick steel plate	●8 sheets {4 sheet/cylinder (seed drum) }
4		①Bend the "seed flow control plate" at an angle of 90 degrees between fins and the face of the holes (L-shaped yellow arrows). ②Apply the "seed flow control plate" to the inner side of the "cylinder (seed drum)" and determine the bend of the plate. Make two marks for the rivets. Drill two 4mm rivet holes.		●Marker ●Drill ●Drill bit for steel ϕ 4mm ●Hammer ●Vice-grip pliers ●Same length and L-shaped metal sheet (approx. 1 inch X approx. 1 inch)	●8 sheets {4 sheet/cylinder (seed drum) }
5		①Rivet the "seed flow control plate" to the inside of the cylinder (seed drum). ※The rivet direction should be referred to "3. Cylinder (seed drum) 1A, 1B."	●Rivet= ϕ 3.2 X 13	●Riveter ●Rivet	●8 sheets {4 sheet/cylinder (seed drum)}

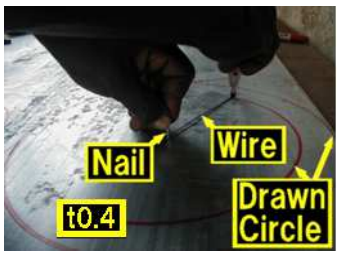
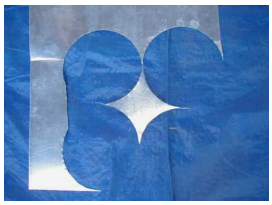
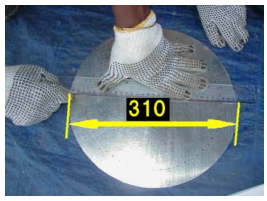
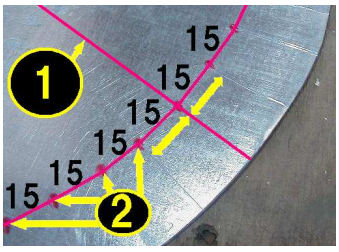
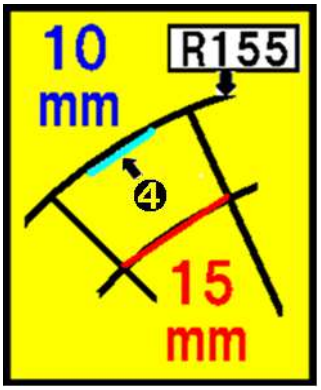
5.Lid (seed inlet)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		①Seed outlet(refer to 3-3)Likewise, a 5mm rim should be bent around the four sides of the lid using the pliers. ② Bent sides should be flattened completely (180 degrees bend) by using the hammer.	● Metal sheet = 140 X 160 thickness =0.4	●Ruler ●Metal shears ●Pliers ●Hammer ●Anvil or thick steel plate	●2 metal sheets
2	 	① The lid material should be pressed tightly against the column by both hands, creating a curved surface, so that the lid will be shaped to fit to the cylinder tightly when being attached. ※Mark the rivet hole positions with a marker pen.		● Marker pen ● Column, used in the "3. Cylinder (seed drum) -6"	●2 sheets
3	  	① Centerpunch four points, two for each hinge (hinge/Rivet holes = 40mm). ② Drill 4mm holes where the centerpunch points are made. ※ Drill holes on a wooden block.		●Ruler ●Marker pen ●Centerpunch ●Hammer ●Drill ●Drill bits for steel ϕ4mm ●Wooden block	●2 sheets

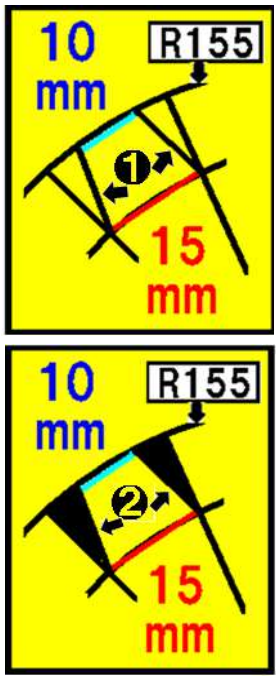
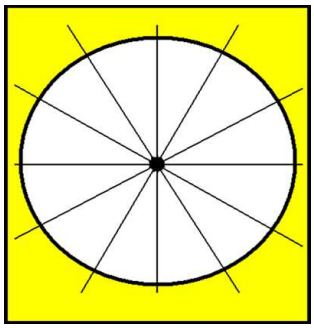
5.Lid (seed inlet)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
4	 	● Manufacturing process for the lock of the lid ① Measure and draw to size, lines on the metal sheet. ② Centerpunch rivet hole points (six in total). ③ Drill 4mm holes at each centerpunched position. ※Drilling should be done on a wooden block.	●Metal sheet = 20 X 50 thickness =1.5	●Ruler ●Marker pen ●Centerpunch ●Hammer ●Drill ●Drill bit for steel ϕ 4mm ●Metal shears	●6 sheets{3 sheets/lid(seed outlet)}
5	 	● Manufacturing process for the lock of the lid ④ Cut out strips for the lid lock using the metal shears. ⑤ Cut along the yellow line to make six strips of metal. ⑥Hammer flat those six strips. ⑦Attach these to the cylinder (seed drum).	● metal sheet = 20 X 50 thickness =1.5	●Metal shears ●Hammer ●Metal undersheet or thick steel plate	●6 sheets {3 sheets / lid (seed outlet) }
6					

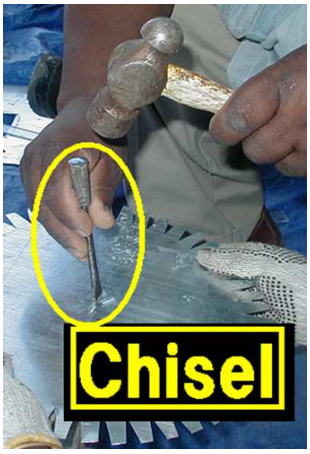
6. Side Plates of Cylinder Drum (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1	 	①Bend and shape the wire at the both ends. One end should be looped to accommodate a nail. The other end should be bent to the appropriate length and to accommodate the marker pen. Adjust the length of the wire in order to draw a circle with a radius of 155mm (the outer circle) and then readjust the length to draw a circle with a radius of 125mm. ②In order to create the above mentioned circles, a nail should be placed and lightly hammered into position on the metal sheet. ※The nail should be placed through the looped end of the wire, held in position and kept vertical. The marker pen should be placed at the other end of the wire. ③Draw four sets (one innder and another outer)	●Metal sheet= 0.4 thickness ●Radius of the inner circle =125 ●radius of the outer circle =155	●Marker pen ●Wire (approx. 200mm long) ●Long-nose pliers ●Nail ●Hammer	●4 sheets{2 sheets / cylinder (seed drum)}
2	 	①Cut away four outer circles (the ones with a radius of 155mm) using the metal shears. ②Make sure that the diameter of each cut away circle is 310mm.	●Radius=155	●Metal shears	●4 sheets{2 sheets / cylinder (seed drum)}
3	 	①Draw one diameter line using the marker pen. ②Mark one dot at the intersection between the diameter line and the inner circle circumference line. This dot should be repeated every 15mm around the circumference of the inner circle. ③Position the ruler between the center of the circle and any one of the dots marked on the circumference of the inner circle, score a line, using the nail, from the dot on the inner circumference all way to the circumference of the outer circle.。 ④As illustrated on the left, draw a 10mm line (indicated in blue) positioned centrally on the outer circumference between each of the scored lines.		●Ruler ●Marker pen ●Nail	●4 sheets {2 sheets / cylinder (seed drum)}

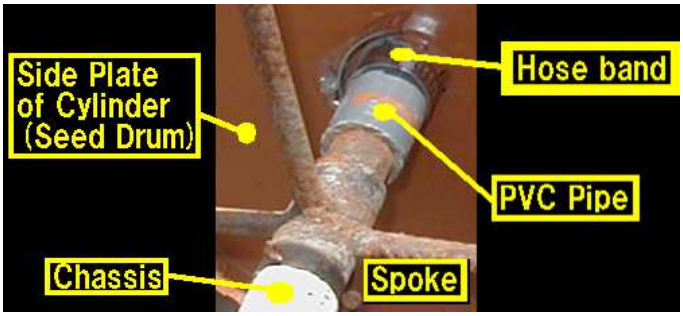
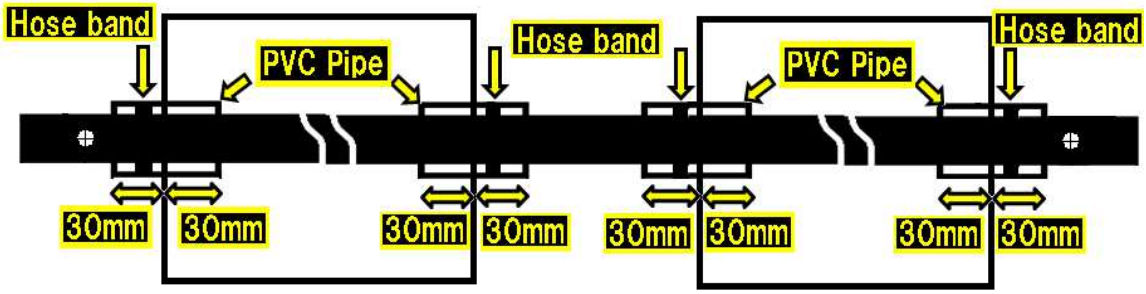
6. Side Plates of Cylinder Drum (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
4		①As illustrated on the left, draw a straight line connecting the ends of the 10mm line, marked on the outer circumference, with the dots, marked on the inner circumference. ②As illustrated on the left, cut away the black parts using the metal shears.   ③Imagine this is the face of a clock, drill one hole at the center of each of twelve fins positioned as in the face of a clock.		●Ruler ●Metal shears ●Centerpunch or nail ●Drill ●Drill bit for steel ϕ 4mm	●4 sheets{2 sheets / cylinder (seed drum)}
5		①The fins of the disk of the metal should be bent at the line of the inner circumference (r125mm) to an angle of 90 degrees. This could be done by using anything circular and having a 90 degree angle, such as an air cleaner element. (See the picture on the left.)		●Any cylinderical shaped object such as a used air clearner element, a metal cylinder etc. to help the fins to be bent. ●Hammer	●4 sheets{2 sheets / cylinder (seed drum)}
6	 	●Making a hole through which the axle can be placed ①Draw a circle of 15mm radius positioned around the same center point as the two previous circles (inner and outer circles). The method of drawing is the same as that of the inner and outer circles. ②Divide and mark the circle drawn in ① into twelve equal segments. (See the illustration on the left)	Diameter=30	●Wire (approx. 100mm long) ●Marker pen ●Nail	●4 sheets{2 sheets / cylinder (seed drum)}

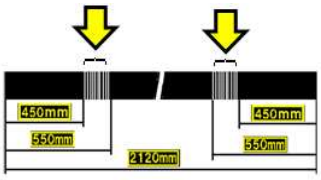
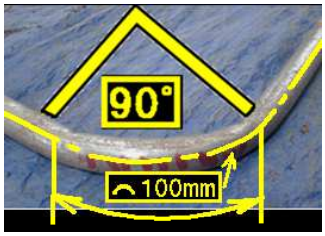
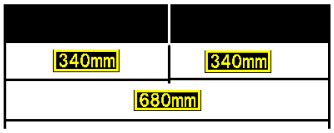
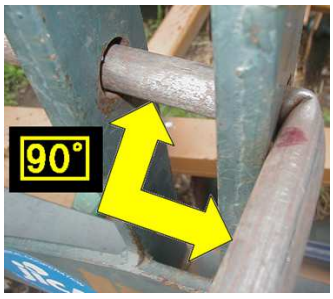
6. Side Plates of Cylinder Drum (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
7		①Cut along the marked lines of each of the twelve divided segments. (Picture) ※Use a metal undersheet as when used for the seed inlet preparation.	Diameter=30	●Chisel ●Hammer ●Metal undersheet or thick steel plate	●4 sheets{2 sheets / cylinder (seed drum)}
8	 	①Prise open the cut sections, using the long-nose pliers, so that each of the sections are pointing upwards. (See the picture on the left.) ②This is the completed hole for the axle. (See the picture on the left.)	Diameter=30	●Long-nose pliers	●4 sheets {2 sheets / cylinder (seed drum)}
9	 	①Place the side plates onto the cylinder ends and rivet at the twelve drilled points, as shown on the left.	●Aluminum rivet ϕ3.2 X 13	●Centerpunch ●Drill ●Drill bit for steel ϕ4mm ●Riveter	●4 sheets{2 sheets / cylinder (seed drum)}

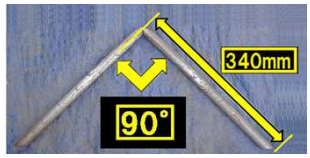
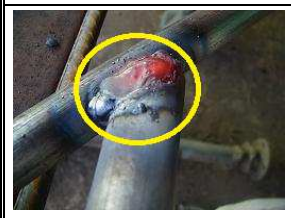
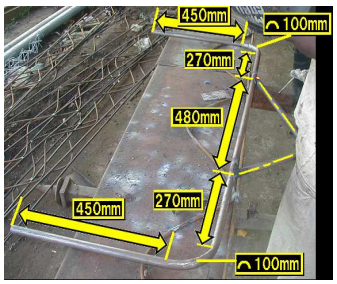
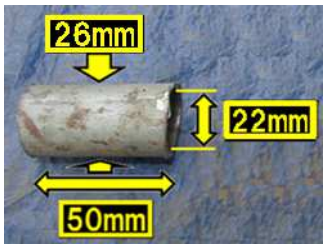
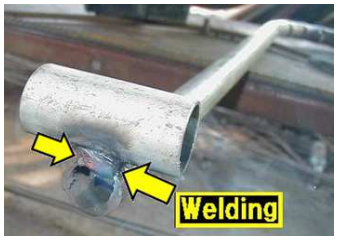
6. Side Plates of Cylinder Drum (seed drum)

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
10	<Refer to the picture 11 shown below.>	①The axles, made in「2. Axle」, should be placed within the two cylinder drums. ②Decide or determine the distance between the two cylinder drums. See a picture「2.Axle-1」. ③Stablize them by using four hose bands.	●Hose band approx. ϕ 30	●Tape measure ●Screw driver (minus)	●4 sheets{2 sheets / cylinder (seed drum)}
11	 				

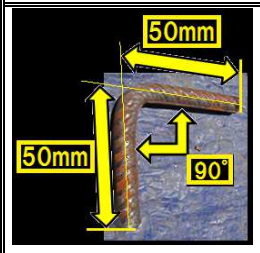
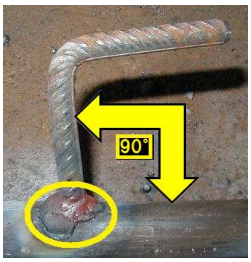
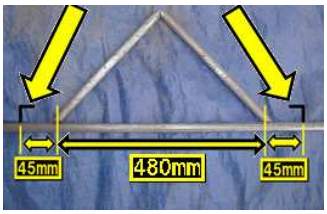
7. Chassis

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		①Cut the round steel pipe for the main chassis section. ②Mark ten bending points between 450mm and 550mm from the both ends of the bar. (two locations)	●length =2120 ●internal diameter =22 ●external diameter =26	●Marker pen ●Tape measure ●Electric grinder (cutting disk), or hacksaw	●1
2	 	①Put the round steel pipe into the hole of the bending jig. ②Place one of the marks against the edge of the hole of the bending jig. ③Use the pipe wrench to bend the bar at the mark. Bend by increments at each mark until an arch of 90 degree has been created.	●length of bent arch =100	●Jig (The coupling mechanism of a tractor that is no longer in use can be utilized for this purpose.) ●Pipe Wrench	●2 locations / steel pipe
3		①The length of the bent arch is 100mm.			●2 locations / steel pipe
4		●Manufacturing of the secondary chassis section ①Cut the secondary chassis section length that will hold the bolt. This bolt will allow the handle height to be adjusted. ②Mark a line for a bending point at the center of the bar, 340mm from the both ends.	●length =680 ●external diameter =26 ●external diameter =22	●Maker pen ●Tape measure ●Electric grinder (cutting disk), or hacksaw	●1 / steel pipe
5		①Put the secondary chassis section into the hole of the bending jig. ②Bend the bar at the marked point to the angle of 90 degrees.		●Jig (The coupling mechanism of a tractor that is no longer in use can be utilized for this purpose.) ●Pipe Wrench	●1 location / steel pipe

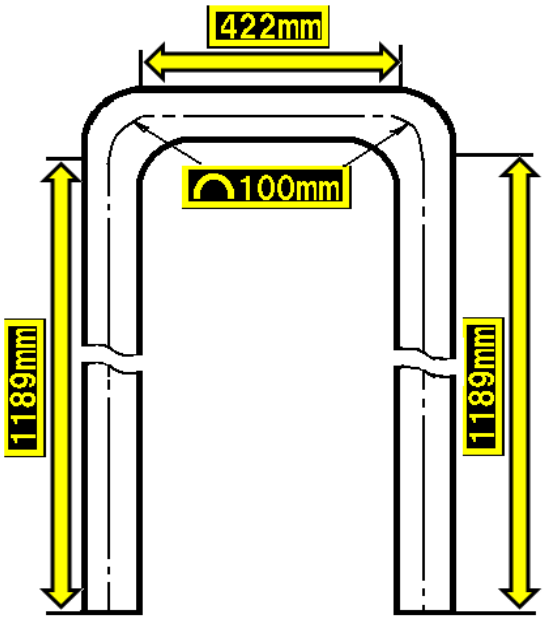
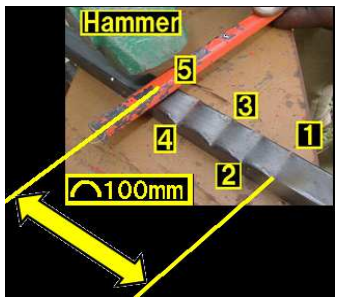
7. Chassis

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
6	 	①Grind down both ends of the bent bar to create a horizontal line between both ends when placed flat against something.		●Electric grinder (cutting disk), or hacksaw ●Flat file	●2 locations / steel pipe
7		①Weld the height adjustable bolt at the mid point of the secondary chassis section.	●Hexagonal bolt M8X50 ●Hexagonal nut M8	●Arc welder	●Hexagonal bolt: 1 / chassis ●Hexagonal nut : 2 / chassis
8	 	①Place both chassis sections on the flat working surface. ②Weld both chassis sections together.	●Refer to the picture on the left.	●Arc welder	●2 locations / chassis
9		①Cut the round steel pipe sections to be connected to the axle (the axle receiver).	●length =50 ●internal diameter =22 ●external diameter =26	●Electric grinder (cutting disk), or hacksaw ●File	●2 locations / chassis
10		①Fix two axle receivers temporarily at each end of the chassis. ②Weld the center point of the axle receiver to the ends of the main chassis section.		●Vice grip pliers ●Arc welder	●2 locations / chassis

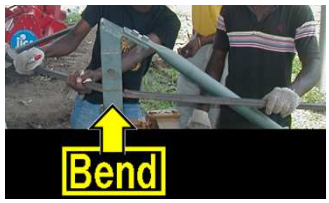
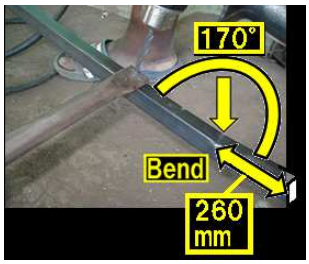
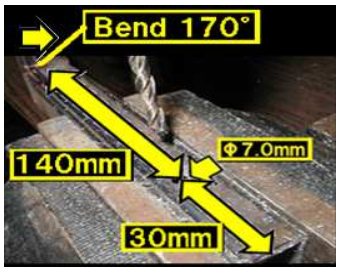
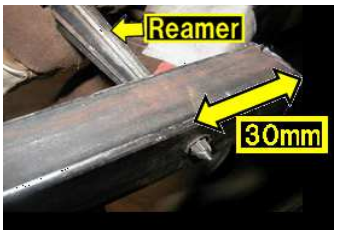
7. Chassis

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
11		①Cut the reinforcing steel bar to be used as a hook for the handle. ②Bend at the center of the bar to create a 90 degree angle.	<Reinforcing bar> ●length =100 ●external diameter =6	●Bench vice ●Hammer ●Electric grinder (cutting disk) ,or hacksaw	●2 locations / chassis
12	 	①To connect the reinforcing steel bar and the chassis section, weld all around the end point of the reinforcing steel bar. The reinforcing steel bar should stand 90 degrees from the main chassis section, with the top bent part pisitioned parallel to the main chassis section.		●Arc welder	●2 locations / chassis

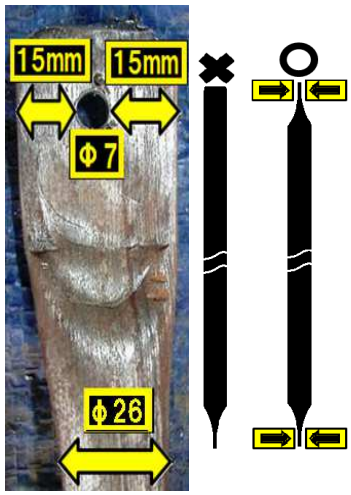
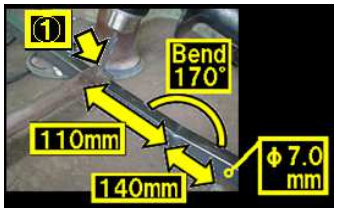
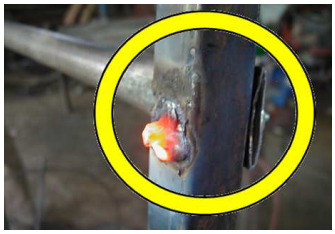
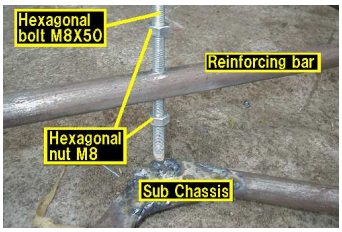
8. Handle

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1					●1
2	 	①Cut the square steel pipe (The material for the handle). ②Process two locations in order to create two 90 degree bends. Arc distance = 100mm/ (See the picture on the left.) ※Hammer and imprinted dent using the hexagonal steel bar. Make five dents for one arc.	<Square steel pipe> 20 X 20 length =3000	●Electric grinder (cutting disk), or hacksaw ●Hammer ●Hexagonal steel bar (such as the handle of the cold chisel)	●two 90 degree arcs / handle
3		①The process of bending the handle should be done using the jig and the pipe wrench. ※In order to create an even bend, the third dent, as shown on the picture above, should be dealt with first.		●Jig (The coupling mechanism of a tractor that is no longer in use can be utilized for this purpose.) ●Pipe wrench	●two 90 degree arcs / handle

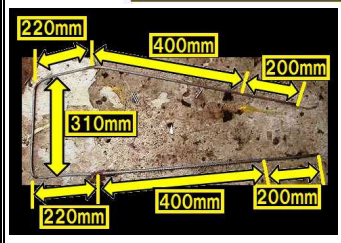
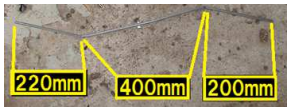
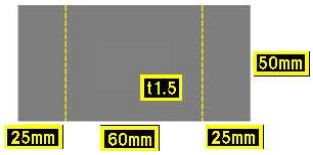
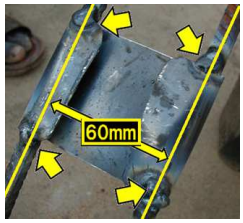
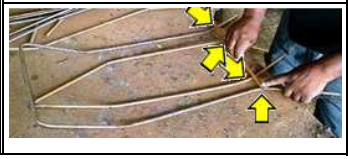
8. Handle

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
4	 	①Bend the square steel pipe at each end by 10 degrees, to create an angle of 170 degrees, by using the jig. (Bend along the face of the steel pipe)		●Jig (The coupling mechanism of a tractor that is no longer in use can be utilized for this purpose.) ●Protractor	●two 170 degree angle bends / handle
5	 	①Drill a hole at each end of the square steel pipe, 30mm from the end, in order to create a hole to connect a handle to the chassis. (There should be a total of four holes, two at each end.) ②In the event that the drill holes are not large enough, use the reamer to widen the holes. (see picture below)		●Electric drill ●Drill bit for steel ϕ7, or reamer	●4 holes / handle
6		●Processing the reinforcing material for the handle. ①Cut the round steel pipe. (This is used as the reinforcing material for the handle.)	length =560 external diameter =26	●Electric grinder (cutting disk), or hacksaw	●1

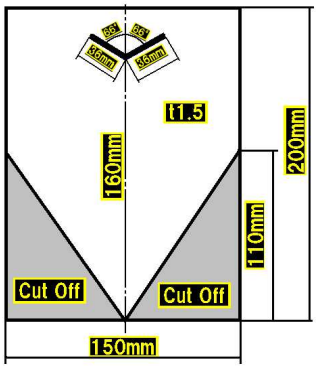
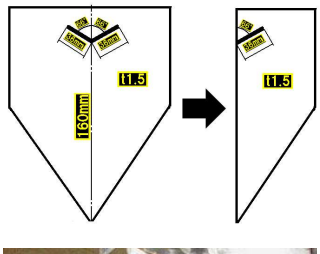
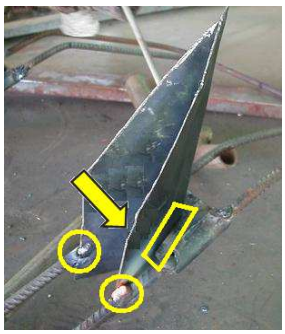
8. Handle

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
7		①Flatten the ends of the round steel pipe using the bench vice. ※Flatten both ends so that they are horizontal to each other. ②Hammer both ends flat, while placed on the metal undersheet of thick steel plate. ③Drill a hole at the center of each flattened end. ④Round the edges of the flattened ends. ※Use an electric grinder or a flat file.	<Round steel pipe> length =570 external diameter =26	●Bench vice ●Metal undersheet, or thick steel plate ●Hammer ●Centerpunch ●Electric drill ●Drill bit for steel Φ7mm ●Flat file	●2 holes / handle reinforcement
8	 	①Create a hole to allow the hexagonal bolt to be welded to the handle, to connect the round steel pipe (the reinforcing material for the handle) to the handle. ②Weld the bolt to the handle. (Picture on the left.)	<Hexagonal bolt> M6X30	●Centerpunch ●Hammer ●Drill ●Drill bit for steel Φ7mm	●2 holes / handle reinforcement
9		●<Refer to "7.Chassis-7"> ①Drill a hole at the center of the reinforcing bar to allow the bolt (M8X50), that adjust the height of the handle, to be placed through the reinforcing bar. ②Position the bolt through the hole of the reinforcing bar.		●Centerpunch ●Hammer ●Drill ●Drill bit for steel Φ9mm, or reamer	●2 holes / handle reinforcement

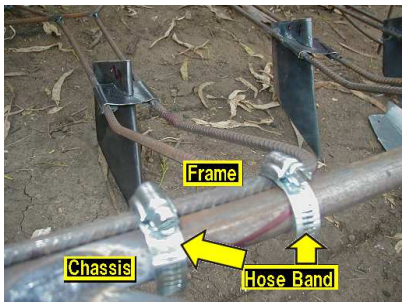
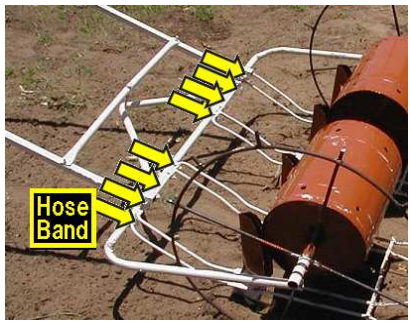
9. Frame

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		①Mark the cutting points on the reinforcing bars. ②Mark the bending points on the reinforcing bars. ③Cut the reinforcing bars at the marked points.	<Reinforcing bar A> ●length =1950 ●external diameter =10 <Reinforcing bar B> ●length =820 ●external diameter =10	●Tape measure ●Marker pen ●Electric griner (cutting disk), or hacksaw	●Reinforcing bar A =2/ row seeder ●Reinforcing bar B =4/ row seeder ●Reinforcing bar C =2/ row seeder
2	 	①Bend the reinforcing bars at the marked points.	●Reinforcing bar A= refer to the picture on the left	●Bench vice	●six bending points / reinforcing bar A
3	 	①Bend the reinforcing bars at the marked points.	●Reinforcing bar B= refer to the picture on the left	●Bench vice	●Two bending points / reinforcing bar B
4		●Process of manufacturing of the furrow cutting stabilization sheet ①Cut the steel sheet. ②Use the file to file down any burrs. ③Place the central ridge line of the reinforcing bar B on the yellow dotted line as shown in the illustration on the left. The distance	<Furrow cutting stabilization plate > ●50X110、thickness 1.5	●Grinder (cutting disk, grinding disk) ●File ●Vice grip pliers ●Hammer	●4 sheets / row seeder
5	 	①Position four reinforcing bar B as shown in the picture on the left. ②Weld the plate to the reinforcing bars. (Weld at four points on the front and the back, as indicated by yellow arrows.)	<Furrow cutting stabilization sheet > ●50X110、thickness 1.5	●Vice grip pliers ●Arc welder	●4 sheets / row seeder
6		①Weld the reinforcing bar C (Weld at four points as indicated by the yellow arrows.)	●Reinforcing bar C= refer to the picture on the left	●Arc welder	●2 sheets / row seeder

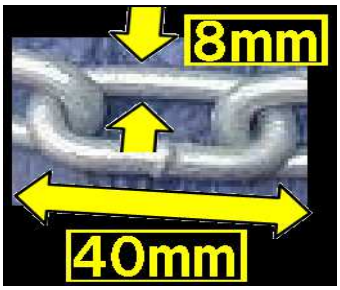
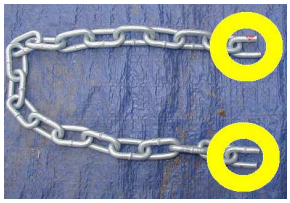
9. Frame

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
7		●Process of manufacturing the furrow cutter ①Draw the shape of the furrow cutter. ②Cut the sheet. ③Smooth the edges of the sheet.	<Furrow cutter> ●200X150、thickness 1.5	●Ruler ●Protractor ●Centerpunch ●Hammer ●Electric grinder (cutting disk) ●File	●4 sheets / row seeder
8	 	①Fold in half the cut sheet at the center line. ※Refer to "3. Cylinder (seed drum) -5" for how to bend ②Partially cut the folded sheet to a depth of 36mm, using the cutting disk,to allow the furrow cutting stabilization sheet to be connected. ③Unfold the furrow cutter as far as is necessary in order that the partial cut can fit into the central space between the furrow cutting stabilization sheet and the reinforcing bar frame.(See the picture No.9)	<Furrow cutter> ●200X150、thickness 1.5	●Hammer ●Vice-grip pliers ●Same length and L-shaped metal sheet (approx. 1 inch X approx. 1 inch) ●Metal undersheet or thick steel plate ●Bench vice ●Electric grinder (cutting disk), or hacksaw ●File	●4 sheets / row seeder
9	 	①Weld together the connected sections. (The furrow cutter should be welded to the furrow cutting stabilization sheet and the reinforcing bar frame.) (Weld inside as indicated by the arrow and outside at the points indicated in the picture on the left.)	<Furrow cutter> ●200X150、thickness 1.5	●Hammer ●Arc welder	●4 sheets / row seeder

9. Frame

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
10	 		●Hose band (approx. φ30, eight necessary) ※Connect「7. Chassis」and「8. Frame」by the hose band.	●Flat headed screw driver	●2 sets / row seeder

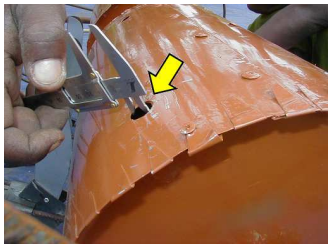
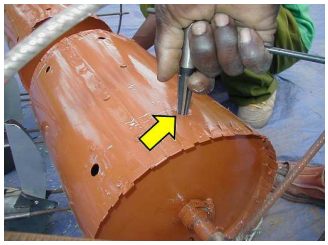
10. Soil Covering Chain

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1	  	●Cutting the chain ①Cut both ends of the chain as shown in the pictures on the left. (Four chains will be created out of eight chain lengths.) ※These are the four chains to be welded to the main body of the raw seeder.	●length =500	●Marker pen ●Electric grinder (cutting disk), or hacksaw	●8 chains / raw seeder
2	 	①As shown in the picture on the left, wire together two chains by connecting the end of one chain to the third link of the other chain that will be welded to the main body of the raw seeder. ②Weld the chains that were complereted in ① to the 9.「Frame」.	<Wire> length = approx. 3000 diameter = approx. 2.0	●Pliers ●Long-nose pliers ●Arc welder	●8 chains / raw seeder

10. Soil Covering Chain

No	Picture	Description	Size (mm)	Tools	Q'ty of Products
3		①Connect together「Soil Covering Chain」and 9.「Frame」.			●2 soil covering chains / frame ●2 frames / raw seeder

11. Painting, Adjustment for Seed Outlet

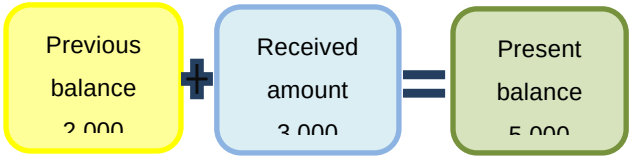
No	Picture	Description	Size (mm)	Tools	Q'ty of Products
1		●Painting ①Shake the paint can before opening. After opening the can, use a clean stick to stir the paint, ensuring to scrape any settled paint. It is preferable not to use a wooden stick as this may contaminate the paint. ②Dilute the paint with the paint thinner. ③Use the paint thinner to clean the paint brush after use, and leave to dry. ④The paint will require a few days to dry. (two to three days)		●Paint ●Paint thinner ●Paint brush ●Empty pet bottle	●1
2	 	●Seed outlet adjustment (to be done on a wind free day) ①Spread a blue sheet on a level piece of ground. ②Introduce the seed rice into both seed drums, filling the seed drums to just below the level of the axle of the seed drum. ③Estimate the volume of seed required for a 1ha field by drawing the row seeder over the top of the blue sheet for a distance of 10m. Make sure all four rows are dispersing seeds consistantly. Collect and weigh all the dispersed seeds from each row. ※In the event that any of the seed rows have not been dispersed consistantly, the 4.「seed row control plate」of that row should be adjusted. Note the size of the seed discharge holes		●Blue sheet (approx. 5m X 12m) ●Vernier calipers ●Scale (1kg) ●Bowl, plate, etc.	●24 holes / row seeder {12 holes / cylinder (seed drum)}
3	 	①The initial seed discharge hole has a 12.0mm diameter. The holes can be enlarge up to 13.5mm. ※Do not enlarge the hole beyond 13.5mm diameter, as it is difficult to undo this adjustment. ②Use the round file to file down any burrs created during the hole enlargement process.	●Hole diameter =13.5	●Vernier calipers ●Reamer ●Round file	●24 holes / row seeder {12 holes / cylinder (seed drum)}

1. Book Keeping on daily basis (FSG)

This section explains how to keep the book.

Example 1 : Receiving Cash

Say there are 2,000M in cash and 5,000Mt in a bank account. Today (15th May), the accountant received 3,000Mt from Mugabe.

<table>
<tr><th>Step</th><th>What to do</th><th>Remarks</th></tr>
<tr><td>1</td><td>Record the date</td><td>
<table>
<tr><td>Date</td></tr>
<tr><td></td></tr>
<tr><td>15-May.</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>Record the purpose</td><td>
Received from who?
Why was it received? (ie. Fund recovery)
<table>
<tr><td>Date</td><td>Purpose</td></tr>
<tr><td>○○○</td><td>○○○○</td></tr>
<tr><td>15-May.</td><td>From Mr. Mugabe for refunding revolving fund</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Record the received amount</td><td>
The received amount should be recorded under “Received” of the “Cash account” section.
<table>
<tr><td colspan="3">Cash account</td></tr>
<tr><td>Received</td><td>Paid</td><td>Balance</td></tr>
<tr><td></td><td></td><td>2,000</td></tr>
<tr><td>3,000</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Calculate the balance</td><td>
The present balance can be calculated to add the previous balance and the received amount. Because there is cash received, this cash should be added.
<table>
<tr><td colspan="3">Cash account</td></tr>
<tr><td>Received</td><td>Paid</td><td>Balance</td></tr>
<tr><td></td><td></td><td>2,000</td></tr>
<tr><td>3,000</td><td></td><td>5,000</td></tr>
</table>


</td></tr>
</table>

5	Write "Remarks"	● Ask the person who made the payment (Mugabe) to sign under "Remarks." ● This proves that Mugabe paid 3,000Mt, so it is very important to do this. Remarks 
6	Write the balance of the "Bank account"	There is no change for the balance of the "Bank account." So 5,000 should be written under the balance.

The book should look like this after the accountant received 3,000Mt from Mugabe.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for refunding revolving fund	3,000		5,000			5,000	

Example 2 : Cash withdrawal from the bank

Next day (16th May), the accountant withdrew 2,200Mt from the bank account.

- In this case, it is required that the accountant record under two sections of the book: first under the "Bank account" then under the "Cash account."

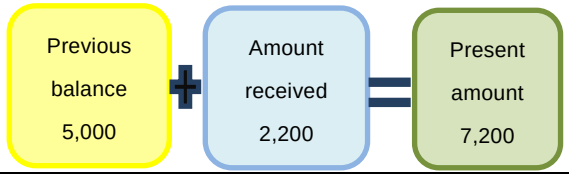
First: Record the withdrawal amount of 2,200Mt under the "bank account."

Step	What to do	Remarks
1	Record the date	Date 16-May.
2	Record the purpose	Write "bank withdrawal" Date | Purpose 16-May. | Bank withdrawal
3	Record the amount of withdrawal	● The amount should be written under the "Withdraw" of the "Bank account."

		Bank account Deposit | Withdraw | Balance | | 5,000 | 2,200 |	
4	Calculate the balance	● The balance is the remaining amount of the previous balance subtracted by the amount of withdrawal. ● Because cash was withdrawn, the balance should be less than before. In this case, subtraction should be done. Bank account Deposit | Withdraw | Balance | | 5,000 | 2,200 | 2,800 Previous balance 5,000 − Amount withdrawn 2,200 = Present balance 2,800
5	Write "Remarks"	● If cash was withdrawn, the number of used bank check should be noted. Remarks Check no: 223569
6	Write the balance of the "Cash account"	● There is no change to the "cash account." So, 5,000 should be written under the balance.

Second : Record 2,200Mt withdrawn from the bank under the "cash account."

Step	What to do	Remarks
1	Record the date	● Write the date of the withdrawal from the bank. Date 16-May
2	Record the purpose	● Write "Cash withdraw from bank." Date | Purpose 16-May. | Cash withdraw from bank
3	Record the amount of the withdrawal	● Write the amount of withdrawal under the "Received" of the "Cash account."

		<table><tr><td colspan="3">Cash account</td><td colspan="3">Bank account</td></tr><tr><td>Received</td><td>paid</td><td>Balance</td><td>Deposit</td><td>Withdraw</td><td>Balance</td></tr><tr><td>3,000</td><td></td><td>5,000</td><td></td><td></td><td>5,000</td></tr><tr><td></td><td></td><td>5,000</td><td></td><td>2,200</td><td>2,800</td></tr><tr><td>2,200</td><td></td><td></td><td></td><td></td><td></td></tr></table> ● The cash withdrawn from the bank is now written to the "cash account."
4	Calculate the balance	● The present balance is the sum of the previous balance and the amount received, so it should be added. It is the same case as with the occasion when members repay to the fund. ● <table><tr><td colspan="3">Cash account</td><td colspan="3">Bank account</td></tr><tr><td>Received</td><td>paid</td><td>Balance</td><td>Deposit</td><td>Withdraw</td><td>Balance</td></tr><tr><td>3,000</td><td></td><td>5,000</td><td></td><td></td><td>5,000</td></tr><tr><td></td><td></td><td>5,000</td><td></td><td>2,200</td><td>2,800</td></tr><tr><td>2,200</td><td></td><td>7,200</td><td></td><td></td><td></td></tr></table> 
5	Write the balance to the "Bank account"	● There is no change to the "bank account." So 2,800 should be written under the balance.

The book would look like this when cash of 2,200Mt is withdrawn.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for refunding revolving fund	3,000		5,000			5,000	
16-May	Cash withdrawal from bank			5,000		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		7,200			2,800	

Example 3 : Cash payment

Say someone has 7,200Mt of cash now and 2,800Mt of deposit in his bank. He purchased paddy seeds on May 17th. He paid 1,000Mt for six bags of seeds each.

<table>
<tr><th>Step</th><th>What to do</th><th>Remarks</th></tr>
<tr><td>1</td><td>Record the date</td><td><table><tr><td>Date</td></tr><tr><td>17-May</td></tr></table></td></tr>
<tr><td>2</td><td>Record the purpose</td><td>● It is necessary to clearly write the following points.
➢ Purchased item ⇒ paddy seeds
➢ Unit price ⇒ 1,000Mt/bag
➢ Number of units ⇒6 bags
<table><tr><td>Date</td><td>Purpose</td></tr><tr><td>17-May.</td><td>6 bags of paddy seeds, 1,000Mt/bag</td></tr></table></td></tr>
<tr><td>3</td><td>Record the amount paid</td><td>● Write the amount under the “paid” of the “Cash account.”
<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>7,200</td></tr><tr><td></td><td>6,000</td><td></td></tr></table></td></tr>
<tr><td>4</td><td>Calculate the balance</td><td>● The present balance is the remaining amount after subtracting the paid amount from the previous balance.
● Because money is paid, the balance of the cash account would be less. So the subtraction should be done here.
<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>7,200</td></tr><tr><td></td><td>6,000</td><td>1,200</td></tr></table> 
</td></tr>
<tr><td>5</td><td>Write “Remarks”</td><td>● It is important to get receipts at any and every time and keep</td></tr>
</table>

		those receipts. Those receipts provide proof of the purchase. ● All of the receipts should be numbered in numerical order, so that they can be recognizable, and should be kept safely. Remarks Reference No.: 001
6	Write the balance of the "Bank account"	● There is no change to the bank account, so 2,800 should be written under the balance.

The book would look like this after paddy seeds are purchased.

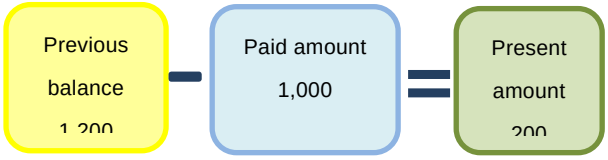
Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for refunding revolving fund	3,000		5,000			5,000	
16-May	Cash withdrawal from bank			5,000		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		7,200			2,800	
17-May	Bought 6 sacks of rice seed, 1,000Mt/sack		6,000	1,200			2,800	Reference No.: 001

Example 4 : Deposit to the bank account

Say, someone has 1,200Mt in cash now and 2,800Mt in his bank account. He deposits 1,000Mt on May 18.

- In this case, book keeping requires a record to be shown under the two sections: first under the "Cash account" and second under the "Bank account."
- Book keeping procedures for depositing cash is the reverse equivalent of cash withdrawal.

First : Record 1,000Mt under the "cash account"

Step	What to do	Remarks
1	Record the date	<table><tr><td>Date</td></tr><tr><td>18-May.</td></tr></table>
2	Record the purpose	● Write "Deposit to the bank account" <table><tr><td>Date</td><td>Purpose</td></tr><tr><td>18-May.</td><td>Deposit to the bank account</td></tr></table>
3	Record the deposit amount	● Write the amount under the "Paid" column of the "Cash account." <table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>1,200</td></tr><tr><td></td><td>1,000</td><td></td></tr></table>
4	Calculate the balance	● The present balance would then be the remaining amount after subtracting the paid amount from the previous balance. ● This calculation is the same when dealing with a cash payment. <table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>1,200</td></tr><tr><td></td><td>1,000</td><td>200</td></tr></table> 
5	Write the balance of the "Bank account"	● There is no change to the bank account, so 2,800 should be written under the balance.

Second : Write the deposited amount, 1,000Mt, to the bank account.

Step	What to do	Remarks
1	Record the date	● Write the date of depositing cash to the bank <table><tr><td>Date</td></tr><tr><td>18-May</td></tr></table>
2	Record the purpose	● Write "Deposit to the bank account"

		Date: 18-May. / Purpose: Deposit to the bank account
3	Record the deposited amount	● Write the deposited amount under the "Deposit" column of the "Bank account." The amount is the same with the one written under the "Paid" of the "Cash account."
4	Calculate the balance	● The present balance is the added amount of the previous balance and the deposited amount. Because cash is received, it should be added. ● This is the same handling when cash is received.
5	Write "Remarks"	● The bank will issue a deposit slip when cash is deposited. These slips should be numbered in numerical order and kept safely.
6	Write the balance of the "Cash account"	● There is no change to the balance of the cash account, so 200 should be written under the balance.

Cash account			Bank account		
Received	Paid	Balance	Deposit	Withdraw	Balance
	6,000	1,200			2,800
	1,000	200			2,800
			1,000		

Cash account			Bank account		
Received	paid	Balance	Deposit	Withdraw	Balance
	6,000	1,200			2,800
	1,000	200			2,800
			1,000		3,800

Remarks
Reference No.: 002

The book would look like this, after depositing 1,000Mt. to the bank.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for refunding revolving fund	3,000		5,000			5,000	
16-May	Cash withdrawal from bank			5,000		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		7,200			2,800	
17-May	Bought 6 sacks of rice seed, 1,000Mt/sack		6,000	1,200			2,800	Reference No,: 001
18-May	Depositing money to bank account		1,000	200			2,800	
18-May	Depositing money to bank account			200	1,000		3,800	Reference No: 002

Example5. Monthly record

Year
Month

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt	(1) Balance from previous month	Mt
	(2) Amount received	Mt	(2) Amount Deposited	Mt
	(3) Total	Mt	(3) Total	Mt
Expenditure	(4) Amount of paid	Mt	(4) Amount of withdrew	Mt
Balance	(5) Balance	Mt	(5) Balance	Mt

Balance of this month

MT.

Prepared by Approved by

Accountant President

It is necessary to make a monthly report at the end of every month. This monthly report should be approved by the President (and the auditor). Moreover, the information in this monthly report should be given to all of the members.

The purpose of making such monthly reports are as follows.

- To summarize monthly activities.
  - To calculate all the income, the expenditures and the balance.
- To share the information among members.

This section explains the way to make such monthly reports, having the following book as an example.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for refunding revolving fund	3,000		5,000			5,000	
16-May	Cash withdrawal from bank			5,000		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		7,200			2,800	
17-May	Bought 6 sacks of rice seed, 1,000Mt/sack		6,000	1,200			2,800	Reference No.: 001
18-May	Depositing money to bank account		1,000	200			2,800	
18-May	Depositing money to bank account			200	1,000		3,800	Reference No: 002

Step	What to do	Remarks
1	Record to the "(1) Balance from previous month"	● Every month, the first line should show the balance brought forward from the previous month.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month

Year: 2013

Month: May

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Amount received	Mt	(2) Amount Deposited	Mt
	(3) Total	Mt	(3) Total	Mt
Expenditure	(4) Amount of paid	Mt	(4) Amount of withdrew	Mt
Balance	(5) Balance	Mt	(5) Balance	Mt

Step	What to do	Remarks
2	Write "(2) Amount received" in the Cash Account and "(2) Amount Deposited" in the Bank Account	● Write all of the received amounts of the cash account ➢ 3,000+2,200=5,200 ● Add all of deposited amounts of the bank account ➢ 1,000

Cash account			Bank account		
Received	Paid	Balance	Deposit	Withdraw	Balance
		2,000			5,000
3,000		5,000			5,000
		5,000		2,200	2,800
2,200		7,200			2,800
	6,000	1,200			2,800
	1,000	200			2,800
		200	1,000		3,800

Year: 2013

Month: May

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Amount received	Mt5,200	(2) Amount Deposited	Mt1,000
	(3) Total	Mt	(3) Total	Mt
Expenditure	(4) Amount of paid	Mt	(4) Amount of withdrew	Mt
Balance	(5) Balance	Mt	(5) Balance	Mt

Step	What to do	Remarks
3	Calculate the "(3) Total" of the Cash account and the bank account	● Add together and write the amount of "(1) Balance from previous month " and "(2) Amount received" of the Cash Account ➢ 2,000+5,200=7,200 ● Add together the amount of "(1) Balance from previous month" and "(2) Amount Deposited" of the Bank Account. ➢ 5,000+1,000=6,000 ● These would be the total incomes of the cash account and bank account.

Year: 2013

Month: May

Item	Cash account	Bank Account
Income	(1) Balance from previous month Mt 2,000	(1) Balance from previous month Mt 5,000
	(2) Amount received Mt5,200	(2) Amount Deposited Mt1,000
	(3) Total Mt7,200	(3) Total Mt6,000
Expenditure	(4) Amount of paid Mt	(4) Amount of withdrew Mt
Balance	(5) Balance Mt	(5) Balance Mt

Step	What to do	Remarks
4	Calculate the expenditure	● All the amounts under the "Paid" column of the "Cash account" should be added. ➢ 6,000+1,000=7,000 ● Add all the amounts under the "Withdraw" column of the "Bank account." ➢ 2,200

Cash account			Bank account		
Received	Paid	Balance	Deposit	Withdraw	Balance
		2,000			5,000
3,000		5,000			5,000
		5,000		2,200	2,800
2,200		7,200			2,800
	6,000	1,200			2,800
	1,000	200			2,800
		200	1,000		3,800

Year: 2013

Month: May

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Amount received	Mt5,200	(2) Amount Deposited	Mt1,000
	(3) Total	Mt7,200	(3) Total	Mt6,000
Expenditure	(4) Amount of paid	Mt7,000	(4) Amount of withdrew	Mt2,200
Balance	(5) Balance	Mt	(5) Balance	Mt

Step.	What to do	Remarks
5	Calculate the balance of the cash account and the bank account	● The balance will be: Total income – Expenditure. ➢ Cash account: 7,200-7,000=200 ➢ Bank account: 6,000-2,200=3,800

Year: 2013

Month: May

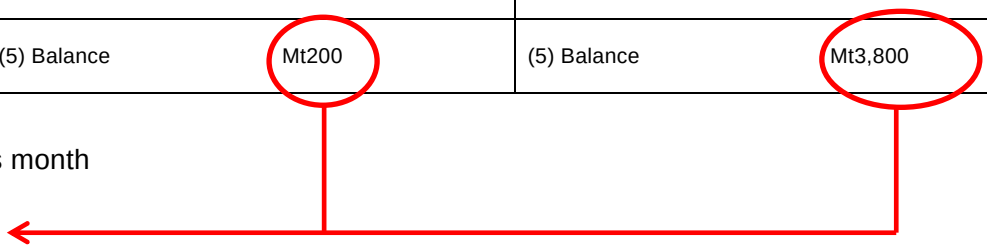
Item	Cash account	Bank Account
Income	(1) Balance from previous month Mt 2,000	(1) Balance from previous month Mt 5,000
	(2) Amount received Mt5,200	(2) Amount Deposited Mt1,000
	(3) Total Mt7,200	(3) Total Mt6,000
Expenditure	(4) Amount of paid Mt7,000	(4) Amount of withdrew Mt2,200
Balance	(5) Balance Mt200	(5) Balance Mt3,800

Subtraction

Step.	What to do	Remarks
6	Calculate the balance for the month	● The balance for the month would be: the balance of cash account + the balance of bank account.

Year
Month

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt2,000	(1) Balance from previous month	Mt5,000
	(2) Amount received	Mt5,200	(2) Amount Deposited	Mt1,000
	(3) Total	Mt7,200	(3) Total	Mt6,000
Expenditure	(4) Amount of paid	Mt7,000	(4) Amount of withdrew	Mt2,200
Balance	(5) Balance	Mt200	(5) Balance	Mt3,800



Balance of this month
MT. 4,000

Prepared by

Accountant

Approved by

President

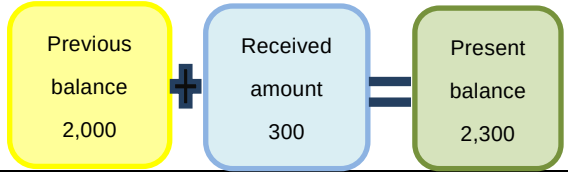
● Both the President and the Accountant should sign off the monthly report. These monthly reports must be given to all of the members.

2. Manage the accounting book on a daily basis (Milling machine management group)

This section explains how to manage the book.

Example 1: Receiving Cash

There are 2,000Mt in cash and 5,000Mt in the bank account. Today, May 15, Mr. Mugabe brought 120kg of paddy to be milled.

<table>
<tr><th>Step</th><th>Item</th><th>Remarks</th></tr>
<tr><td>1</td><td>Write the date</td><td><table><tr><td>Date</td></tr><tr><td>15-May.</td></tr></table></td></tr>
<tr><td>2</td><td>Write the purpose</td><td>● Name of the user who pays the fee
● Purpose for the fee (ie. milling fee for 120kg of paddy)<table><tr><td>Date</td><td>Purpose</td></tr><tr><td>○○○</td><td>○○○○</td></tr><tr><td>15-May.</td><td>From Mr. Mugabe for milling 120kg of paddy</td></tr></table></td></tr>
<tr><td>3</td><td>Write the amount received</td><td>● The received amount should be written under the “Received” column of the “Cash account.”
➢ 2.5Mt/kg×120kg=300Mt<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>2,000</td></tr><tr><td>300</td><td></td><td></td></tr></table></td></tr>
<tr><td>4</td><td>Calculate the balance</td><td>● The present balance is the sum of the previous balance and the received amount. Cash is received, so it should be added.<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td></td><td>2,000</td></tr><tr><td>300</td><td></td><td>5,000</td></tr></table> 
</td></tr>
<tr><td>5</td><td>Write “Remarks”</td><td>● Request for the payer (Mr. Mugabe in this case) to sign under the “Remarks.”
● This step is very important as this signature proves that Mr. Mugabe has paid 300Mt.</td></tr>
</table>

		Remarks
6	Write the balance of the "Bank account"	(a) There is no change to the "Bank account," so write 5,000 under the balance.

The book would look like this after receiving 300Mt from Mr. Mugabe.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for milling 120kg of paddy	300		2,300			5,000	

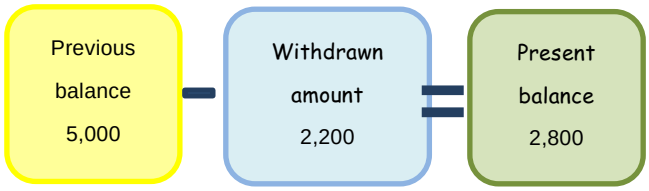
Example 2: Withdrawal of cash from the bank account

Next day, May 16, cash worth of 2,200Mt was withdrawn.

- In this case, there is a need to deal with two accounts: the "Bank account" and the "Cash account."

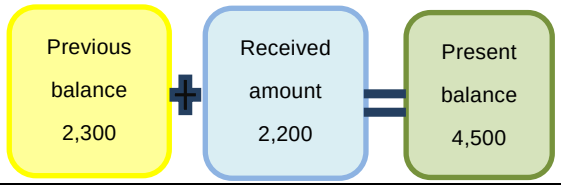
First account: Record 2,200Mt withdrawal to the "bank account."

Step	What to do	Remarks
1	Write the date	Date: 16-May.
2	Write the purpose	Write "Cash withdrawal" under "Purpose." Date: 16-May. / Purpose: Cash withdrawal
3	Write the amount withdrawn	● The withdrawn amount should be written under the "Withdraw" column of the "Bank account." Bank account: Deposit / Withdraw / Balance; 5,000; 2,200

4	Calculate the balance	● The balance is the previous balance subtracted by the withdrawn amount. ● Because cash is withdrawn, the balance will be less. So in this case, subtraction should be done. Bank account Deposit / Withdraw / Balance 5,000 2,200 / 2,800 
5	Write "Remarks"	● When cash is withdrawn, write a numerical number on the check slip for a sorting purpose. Remarks Check no: 223569
6	Write the balance of the "Cash account"	● There is no change to the cash account, so the balance remains as 300. Write 300 under the balance.

Second account: The amount of cash, 2,200Mt, withdrawn from the bank account should be recorded to the "cash account."

Step	What to do	Remarks
1	Write the date	● Write the date when the withdrawal was made. Date 16-May.
2	Write the purpose	● Write "Cash withdrawal from bank" under "Purpose." Date / Purpose 16-May. / Cash withdrawal from bank
3	Write the amount withdrawn	● Write the amount withdrawn under the "Received" column of the "Cash account."

		<table><tr><td colspan="3">Cash account</td><td colspan="3">Bank account</td></tr><tr><td>Received</td><td>paid</td><td>Balance</td><td>Deposit</td><td>Withdraw</td><td>Balance</td></tr><tr><td>300</td><td></td><td>2,300</td><td></td><td></td><td>5,000</td></tr><tr><td></td><td></td><td>2,300</td><td></td><td>2,200</td><td>2,800</td></tr><tr><td>2,200</td><td></td><td></td><td></td><td></td><td></td></tr></table> ● So this records the cash amount of withdrawal to the "cash account."
4	Calculate the balance	● The present balance is a sum of the previous balance and the received amount. Money is received, so it should be added. <table><tr><td colspan="3">Cash account</td><td colspan="3">Bank account</td></tr><tr><td>Received</td><td>paid</td><td>Balance</td><td>Deposit</td><td>Withdraw</td><td>Balance</td></tr><tr><td>300</td><td></td><td>2,300</td><td></td><td></td><td>5,000</td></tr><tr><td></td><td></td><td>2,300</td><td></td><td>2,200</td><td>2,800</td></tr><tr><td>2,200</td><td></td><td>4,500</td><td></td><td></td><td></td></tr></table> 
5	Write the balance of the "Bank account"	● There is no change to the "bank account." So write 2,800 under the balance.

The book would look like this, after 2,200Mt is withdrawn.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for milling 120kg of paddy	300		2,300			5,000	
16-May	Cash withdrawal from bank			2,300		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		4,500			2,800	

Example 3: Paying Cash

Now, there are 4,500Mt cash and 2,800Mt in the bank. A purchase was made on May 17 to get 20L of diesel.

<table>
<tr><th>Step</th><th>What to do</th><th>Remarks</th></tr>
<tr><td>1</td><td>Write the date</td><td>
<table>
<tr><td>Date</td></tr>
<tr><td>17-May.</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>Write the purpose</td><td>
● It is necessary to clearly write the following information.
➢ Purchased item ⇒ diesel
➢ Unit price ⇒ 37.9Mt/L
➢ Purchased number of unit ⇒ 20L

<table>
<tr><td>Date</td><td>Purpose</td></tr>
<tr><td>17-May.</td><td>Bought 20L of diesel
(37.9Mt/L)</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>Write the amount paid</td><td>
● The paid amount should be written under "paid" column of the "Cash account."

➢ 37.9Mt/L×20L=758Mt
<table>
<tr><td colspan="3">Cash account</td></tr>
<tr><td>Received</td><td>Paid</td><td>Balance</td></tr>
<tr><td></td><td></td><td>4,500</td></tr>
<tr><td></td><td>758</td><td></td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Calculate the balance</td><td>
● The present balance is the difference between the previous balance and the paid amount. So it should be: the "previous balance" – the "paid amount."
● Because money is paid, the balance of the cash account will be less. Here, a subtraction should be done.

<table>
<tr><td colspan="3">Cash account</td></tr>
<tr><td>Received</td><td>Paid</td><td>Balance</td></tr>
<tr><td></td><td></td><td>4,500</td></tr>
<tr><td></td><td>758</td><td>3,742</td></tr>
</table>

</td></tr>
</table>

5	Write "Remarks"	● The receipts should be issued every time under every circumstance and keep safely. Those receipts will provide proof of the purchase. ● Those receipts should be numbered numerically and kept safely. Remarks Reference No.: 001
6	Write the balance of the "Bank account"	● There is no change to the bank account. So write 2,800 under the balance.

The book will look like this after buying the diesel.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for milling 120kg of paddy	300		2,300			5,000	
16-May	Cash withdrawal from bank			2,300		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		4,500			2,800	
17-May	Bought 20L of diesel (37.9Mt/L)		758	3,742			2,800	Reference No.: 001

Example 4: Deposit to the bank account

There are 3,742Mt in cash and 2,800Mt deposit in the bank account now. On May 18, 1,000Mt was also deposited into the bank account.

- In this case, there is a need to deal with two accounts: first, the "Cash account" and second, the "Bank account."
- The procedure of recording deposits should be reverse for that of withdrawals.

The first account: Record 1,000Mt deposit to the cash account.

Step	What to do	Remarks
1	Write the date	Date 18-May.

<table>
<tr><td>2</td><td>Write the purpose</td><td>● Write "deposit to the bank account" under the "Purpose."
<table><tr><td>Date</td><td>Purpose</td></tr><tr><td>18-May.</td><td>Depositing money to bank account</td></tr></table></td></tr>
<tr><td>3</td><td>Write the amount deposited</td><td>● Write the amount deposited under "Paid" column of the "Cash account."
<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td>758</td><td>3,742</td></tr><tr><td></td><td>1,000</td><td></td></tr></table></td></tr>
<tr><td>4</td><td>Calculate the balance</td><td>● The present balance is the previous balance minus the paid amount.
● It is the same calculation as when cash is paid.
<table><tr><td colspan="3">Cash account</td></tr><tr><td>Received</td><td>Paid</td><td>Balance</td></tr><tr><td></td><td>758</td><td>3,742</td></tr><tr><td></td><td>1,000</td><td>2,742</td></tr></table>
 
</td></tr>
<tr><td>5</td><td>Write the balance of the "Bank account"</td><td>● There is no change to the bank account. So the balance remains as 2,800.</td></tr>
</table>

The second account: Record 1,000Mt deposit to the bank account.

<table>
<tr><th>Step</th><th>What to do</th><th>Remarks</th></tr>
<tr><td>1</td><td>Write the date</td><td>● Write the date that the deposit was made.
<table><tr><td>Date</td></tr><tr><td>18-May.</td></tr></table></td></tr>
<tr><td>2</td><td>Write the purpose</td><td>● Write "deposit to the bank account" under purpose.
<table><tr><td>Date</td><td>Purpose</td></tr><tr><td>18-May.</td><td>Depositing money to bank account</td></tr></table></td></tr>
</table>

3	Write the amount deposited	● Write the amount deposited under "Deposit" column of the "Bank account." The amount should be the same with the one written under "Paid" column of the "Cash account."
4	Calculate the balance	● The present balance should be the sum of the previous balance and the deposited amount. Cash is received, so it should be added. ● This is the same case when cash is received.
5	Write "Remarks"	● When cash is deposited to a bank, the bank will issue a deposit slip. This slip should be numbered numerically and kept safely.
6	Write the balance of the "Cash account"	● There is no change for the cash account. So write 2,742 under the balance.

Cash account			Bank account		
Received	Paid	Balance	Deposit	Withdraw	Balance
	758	3,742			2,800
	1,000	2,742			2,800
			1,000		

Cash account			Bank account		
Received	paid	Balance	Deposit	Withdraw	Balance
	758	3,742			2,800
	1,000	2,742			2,800
			1,000		3,800

Previous balance 2,800 + Deposited amount 1.000 = Present balance 3.800

Remarks
Reference No.: 002

After depositing 1,000Mt into the bank account, the book will look like this.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for milling 120kg of paddy	300		2,300			5,000	
16-May	Cash withdrawal			2,300		2,200	2,800	Check no: 223569

	from bank							
16-May	Cash withdrawal from bank	2,200		4,500			2,800	
17-May	Bought 20L of diesel (37.9Mt/L)		758	3,742			2,800	Reference No.: 001
18-May	Depositing money to bank account		1,000	2,742			2,800	
18-May	Depositing money to bank account			2,742	1,000		3,800	Reference No: 002

Example 5: Writing Monthly Report

Year
Month

Item	Cash account	Bank Account
Income	(1) Balance from previous month Mt	(1) Balance from previous month Mt
	(2) Milling Mt	(2) Amount Deposited Mt
	(3) Selling bran Mt	(3) Total Mt
	(4) Cash withdrawal Mt	
	(5) Others Mt	
	(6) Total Mt	
Expenditure	(7) Diesel Mt	(4) Amount withdrawn Mt
	(8) Oil Mt	
	(9) Sapir parts/ Repairs Mt	
	(10) Salary Mt	
	(11) Deposit to bank Mt	
	(12) Other Mt	
	(13) Total Mt	
Balance	(14) Balance Mt	(5) Balance Mt

Balance of this month

MT .

Prepared by Approved by

Accountant President

It is necessary to write a monthly report at the end of every month. The monthly report should have approval from the President (and the auditor) and should be shared with all the other members.

The purposes of such a monthly report is as follows.

- It is to summarize the monthly activities.
  - All of revenues, expenditures and balance of the month should be calculated.
- All the information are shared among all of the members.

This chapter explains the method of writing the monthly report, having the following book keeping as a reference. The following is an example of book keeping of the month of May.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month
15-May	From Mr. Mugabe for milling 120kg of paddy	300		2,300			5,000	
16-May	Cash withdrawal from bank			2,300		2,200	2,800	Check no: 223569
16-May	Cash withdrawal from bank	2,200		4,500			2,800	
17-May	Bought 20L of diesel (37.9Mt/L)		758	3,742			2,800	Reference No.: 001
18-May	Depositing money to bank account		1,000	2,742			2,800	
18-May	Depositing money to bank account			2,742	1,000		3,800	Reference No: 002
19-May	From Mr. Mabunda for milling 150kg of paddy	375		3,117			3,800	
19-May	From Mr. Sitoe for milling 125kg of paddy	312.50		3,429.50			3,800	
22-May	Bought 10L of Oil		1,200	2,229.5			3,800	Reference No: 003
22-May	Bought spare parts		1,500	729.50			3,800	Reference No: 004
24-May	From Ms. Palmera for milling 130kg of paddy	325		1,054.50			3,800	
25-May	Cash withdrawal from bank			1,054.50		1,500	2,300	Check no: 223570
25-May	Cash withdrawal from bank	1,500		2,554.50			2,300	
26-May	Sold 100kg of bran to	150		2,704.50			2,300	

	Mr. Chambal							
31-May	Paid salary (operator)		1,000	1,704.50			2,300	
31-May	Paid salary (President)		1,000	704,50			2,300	

Step.	What to do	Remarks
1	Write the "(1) Balance from previous month"	Every month, the previous balance should be carried forward and be written in the first row of the book of the next month.

Date	Purpose	Cash account			Bank account			Remarks
		Received	Paid	Balance	Deposit	Withdraw	Balance	
1-May				2,000			5,000	Balance from previous month

Year: 2013

Month: May

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Milling	Mt	(2) Amount Deposited	Mt
	(3) Selling bran	Mt	(3) Total	Mt
	(4) Cash withdrawal	Mt		
	(5) Others	Mt		
	(6) Total	Mt		

Step.	What to do	Remarks
2	Calculate the revenues from the cash account and the bank account.	**Cash Account** ● Add all of the revenues and write the result into the "(2) Milling." ➢ 300+375+312.50+325=1,312.50 ● Add all of the money earned by selling bran and write the result into the "(3) Selling bran." ➢ 150 ● Add the amount of all of the withdrawals and write the result into the "(4) Cash withdrawal." ➢ 2,200+1,500=3,700 ● If there are other revenues, write that into the "(5) Others." ● Add the figures from (1) to (5), and write the sum into the "(6) Total." ➢ 2,000+1,312.50+150+3,700 **Bank Account** ● Add all of the amount deposited to the bank, and write the result into the "(2) Amount of deposited." ➢ 1,000 ● Add (1) and (2), and writhe the sum into the "(3) Total." ➢ 5,000+1,000=6,000

Year: 2013

Month: May

Item	Cash account	Bank Account
Income	(1) Balance from previous month Mt 2,000	(1) Balance from previous month Mt 5,000
	(2) Milling Mt 1,312.50	(2) Amount Deposited Mt1,000
	(3) Selling bran Mt 150	(3) Total Mt6,000
	(4) Cash withdrawal Mt 3,700	
	(5) Others Mt 0	
	(6) Total Mt 7,162.50	

Step.	What to do	Remarks
3	Calculate the expenditures of the cash account as well as the bank account.	**Cash account** ● Add all the payments for diesel and write the sum under the "(7) Diesel." ➢ 758 ● Add all the payments for buying oil and write the sum under the "(8) Oil." ➢ 1,200 ● Add all the payments for spare parts and write the sum under the "(8) Spare Parts." ➢ 1,500 ● Add all the remuneration and write the sum under the "(9) Salary." ➢ 1,000+1,000=2,000 ● Add all the deposited amounts and write the sum under the "(10) Deposit to bank." ➢ 1,000 ● If there are other expenditures, write that under the "(11) Other." ● Add amounts from (7) to (12) and write the sum under the "(13) Total." **Bank Account** • Add all of withdrawn amount and write the sum under the "(4) Amount withdrawn." • 2,200+1,500=3,700

Expenditure	(7) Diesel	Mt 758	(4) Amount withdrawn Mt 3,700
	(8) Oil	Mt 1,200	
	(9) Spare parts/ Repairs	Mt 1,500	
	(10) Salary	Mt 2,000	
	(11) Deposit to bank	Mt 1,000	
	(12) Other	Mt 0	
	(13) Total	Mt 6,458	

Step.	What to do	Remarks
4	Calculate balance for both the "Cash account" and the "Bank account"	Total Revenues – Total Expenditures = Balance • Cash Account ➢ 7,162.50 – 6,458 = 704.50 ● Bank Account ➢ 6,000 – 3,700 = 2,300

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Milling	Mt 1,312.50	(2) Amount Deposited	Mt 1,000
	(3) Selling bran	Mt 150	(3) Total	Mt 6,000
	(4) Cash withdrawal	Mt 3,700		
	(5) Others	Mt 0		
	(6) Total	Mt 7,162.50		
Expenditure	(7) Diesel	Mt 758	(4) Amount withdrawn	Mt 3,700
	(8) Oil	Mt 1,200		
	(9) Spare parts/ Repairs	Mt 1,500		
	(10) Salary	Mt 2,000		
	(11) Deposit to bank	Mt 1,000		
	(12) Other	Mt 0		
	(13) Total	Mt 6,458		
Balance	(14) Balance	Mt 704.50	(5) Balance	Mt 2,300

Step.	What to do	Remarks
5	Calculate the balance for the month	● The balance of the present month can be calculated by addition: balance of the cash account + balance of the bank account.

Item	Cash account		Bank Account	
Income	(1) Balance from previous month	Mt 2,000	(1) Balance from previous month	Mt 5,000
	(2) Milling	Mt 1,312.50	(2) Amount Deposited	Mt 1,000
	(3) Selling bran	Mt 150	(3) Total	Mt 6,000
	(4) Cash withdrawal	Mt 3,700		
	(5) Others	Mt 0		
	(6) Total	Mt 7,162.50		
Expenditure	(7) Diesel	Mt 758	(4) Amount withdrawn	Mt 3,700
	(8) Oil	Mt 1,200		
	(9) Spare parts/ Repairs	Mt 1,500		
	(10) Salary	Mt 2,000		
	(11) Deposit to bank	Mt 1,000		
	(12) Other	Mt 0		
	(13) Total	Mt 6,458		
Balance	(14) Balance	Mt 704.50	(5) Balance	Mt 2,300

Balance of this month

MT. 3,004.50

Prepared by

Accountant

Approved by

President

- Both the President and the Accountant must sign off the monthly reports. Those monthly reports must be shared among all of the members at general meetings.

The project implementation team

Name	Organization / Role in PROMPAC
Inácio Mateus MUGABE (Mr.)	SDAE / Project manager
Kiyoshi MASUBUCHI (Mr.)	JICA / Chief Advisor & Rice Cultivation
Masahiro OTAKE (Mr.)	JICA / Extension & Farmers Organization
Asako RIERA (Ms.)	JICA / Coordination / Training
Jorge Junior de ALMEIDA (Mr.)	SDAE / Extension
Arseino Fransisco LHAMINE (Mr.)	SDAE / Extension
Jerinho Zacarias CUMBE (Mr.)	SDAE / Extension
Baptista Acacio MACUACUA (Mr.)	SDAE / Extension
Vania Dulce MACULA (Ms.)	SDAE / Extension
Naoyoshi KAWANO (Mr.)	JICA / Social Economic & marketing
Teruhisa NAMBA (Mr.)	JICA / Agronomy (rice)
Olga Mario CHAGUALA (Ms.)	EAC / Agronomy
Tomas Antonio MASSINGUE (Mr.)	EAC / Agronomy
Toru HAMANAKA (Mr.)	JICA / Agricultural Machinery and Equipment
Naftal Tristelio MACHAVA (Mr.)	EAC / Agricultural Machinery and Equipment
Takashi KURAUCHI (Mr.)	JICA / Irrigation & Water Management
Eduardo Cesar MULUANA (Mr.)	HICEP / Irrigation & Water Management
Raul Abel CHAMBAL (Mr.)	HICEP / Irrigation & Water Management
Calvino Andre CHANQUE (Mr.)	EAC / Assistant
Avelino Samuel SITOE (Mr.)	PROMPAC / Driver& Assistant
Sergio Amosse CUINICA (Mr.)	PROMPAC / Driver & Assistant

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Contact

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