ANNEX C IMPROVEMENT OF WATERING

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C.1 Watering using Small Pumps in Groups

The farmers in the Study Area stress the inconvenience of fetching water. Water is transported using polyethylene tanks from water sources such as ponds, Kisima and rivers to the farm for watering. This work is one of the heaviest for them since they have to go back and forth between the farm and the water sources many times. To improve this situation, the farmers strongly desire to have pumps. However, pumps are not popular due to high initial cost and difficulty to acquire optimal small pumps for small farms individually.

Small pumps were introduced and tried in the Verification Study to ensure stable farming that is not affected by weather, increase of crop yield and reducing the labour of water fetching. Prior to introducing the pumps, groups should be formed, and the members of each group collaborated to decide a watering plan, then the suitable pump was procured in accordance with the plan drawn up. This way would save initial cost per farmer and create a sense of ownership on the facilities as well.

The members also carried out operation and maintenance of the facilities jointly after the acquisition of the pumps, contributing in promoting group activities. Irrigation farming required farmers' collaboration on maintaining joint facilities, as the water source was limited. In the Study Area, the farmers needed not to make group work then, as they watered using polyethylene tanks individually. However, after introduction of the pumps, the group work became inevitable. Moreover, such group activities made the access to government services easier.

1.1 Flow of Study

The study was executed according to the following steps.

	Item	Contents
①	Confirmation of group members	Group formed at field study 1 was confirmed. Viziwaziwa：some change observed Mwanabwito：no change Ruvu Darajani：no change
②	Investigation of farm and water source	Possibility of irrigation was investigated from a point of land condition. Possibility of irrigation was judged according to distance and difference of height between farmland and water sources. The distance should be less than 50 m and height should be less than 5 m. Viziwaziwa：no problem Mwanabwito：Farm land of group No.1 is located more than100 m from water sources. Therefore the Team requested to change the site of farmland. Ruvu Darajani：no problem

③	Kind of pump (through field survey)	Type of pump was clarified according to the water sources. Viziwaziwa : Treadle pump was suitable because of water sources. Mwanabwito : Engine pump is usable because the water source is Ruvu River with enough water. Ruvu Darajani : Engine pump is usable because the water source is Ruvu River with enough water.
④	Choice of pump type (through workshops)	After explanation on initial cost and running cost, and capacity of each pump, discussion was made among groups. It is necessary for using engine pump to have enough water available. Treadle pump was recommended in case of small amount of water. Viziwaziwa : Water source is only kisima, therefore, availability of water is limited. That is why, treadle pump was chosen. Mwanabwito : Water use is not limited, because Ruvu River is the water source. Farmers chose engine pump considering expansion of farmland in future. Ruvu Darajani : Water use is not limited, because Ruvu River is water source. Farmer chose engine pump considering expansion of farmland in the future.
⑤	Storage of pump	Each group decided a place where the pumps were safely kept.
⑥	Irrigation method	Irrigation method was decided considering running cost and efficiency. Running cost is directly affected by irrigation method. Therefore, the following method will be taken according to pump type. Engine pump : After pumping water in tank, farmers will supply water using plastic container, whose capacity is almost 20 litres. Treadle pump : Watering vegetables from water source will be executed without water tank.
⑦	Decision of type of water tank	It is necessary to prepare water tank for the farmland where engine pump is adopted.

Summary of field survey is shown as mentioned above, and details are shown as follows.

Field Survey

Items ① to ③ were executed at first field survey for each village. It was carried out from 13th to 14th for Viziwaziwa and from 27th to 31st of August for Mwanabwito and 3rd of September for Ruvu Darajani. It took more time for investigation at Mwanabwito, because farms of each group are so scattered.

① **Confirmation of group members**

② **Investigation farm and water source**

③ **Explanation about type of pump**

Way of investigation： Members are asked to come to the site where the workshop was held, then one member guided the Team to their farms while the other member waited. First of all, ① names of members and group leader were confirmed.

For ②, confirmation of farm and water source, the village extension officer or DSMS(District Special Matter Specialist, Irrigation) measured size of farm and different height between farm land and water surface of source using measuring tape (steel measuring tape, length 30 m) with members. Also depth and diameter of Kisima were measured.

Result of investigation： Characteristic of each village

Viziwaziwa : Kisima is excavated within a farm land. The farmers used this Kisima as water source for vegetable in dry season. These farmlands are used for paddy in rainy season. Their way of watering that uses a plastic container seems to minimise the amount of water use. They apply water directly to the vegetable observing the conditions of their growing. Therefore we thought that this method is suitable for this area. However, through estimation, it was found that the amount of applied water was too much compared with the evapotranspiration. (Refer to Attachment 1 "Experiment on Water Consumption")

Water sources of four farmers of the group No.5 are pond and Kisima. They get water from the pond directly or through canal. This source is surface water, which is different from other groups of using ground water. However, size of pond is not too large to keep water through the year. We investigated that there was a little water last March. So that, the expansion of cultivated land for irrigation is very hard because of limited water source. Accordingly, the purpose of improving water facility should be to reduce labour force using pump but not getting more incomes by it, so that it is desirable that cost of pump is cheap.

The farmer varies the size of cultivated land according to the amount of water availability, which range from 0.1ha to 0.3ha. Size of Kisima is almost same, the width being 4 to 5m and depth about 2m.

There is some lands that are rented, but most lands are owned by the farmers. Farm works are carried out individually in most cases, but some collaborate with neighbours.

Mwanabwito：Water source is Ruvu River. Their farmlands are located in the flood area. Paddy is cultivated in rainy season using flood. Remaining water of flood is utilized for vegetable in dry season. Vegetable cultivation in dry season starts after the rainy season and continues a long period depending on the height of land. This means that a farmer cultivates vegetable in relatively high place when water level remains high, and in relatively low place when water level goes down. The soil in this area is productive even without fertilizer due to flood. A member said that there was one farmer who used an engine pump. However, this farmer stays very far from the site crossing the river. Therefore we failed to meet him.

All of the farmlands for this verification study are leased lands in Mwanabwito. Some lands are used for vegetables, the others are left without cultivation. A farmer says that there is a plenty of

land and it is very easy to rent it.

Difference of height between water surface and a farmland is almost 5m and the size of land varies from 0.2ha to 3 ha. Groups who owned small area want to try a pump as a new experience, and a group who owns large area wants to use a part of their land as a trial.

Farm works will be carried out under collaboration with group members.

Water source is river water, therefore amount of water is not a limiting factor for irrigation plan.

Ruvu Darajani : Site condition is almost same as Mwanabwito. Because water source is Ruvu River and their land is located in a flood area.

The group members can get land free of charge from village authority, which is the village's property. Size of area is 1.4ha for five groups, and the land will be divided into five. Group members said that a pump is not found in this area. Therefore, vegetable cultivation with pump irrigation is quite new for them. They are willing to try to use a pump as a new experience. If results are good, they would want to extend their field for vegetables.

Difference of height between water surface and farmland is about 4m and distance between water source and centre of farm where water tank will be constructed is about 50m.

Decided matter : Decision of changing members is left to the farmers. The following conditions are needed to form groups for introduction of watering facilities.

- Water source for watering is stable.
- Distance between a farm and a water source is within the limit of pump head.
- Farms of each member do not broadly scatter as they jointly use the pump.

If these conditions of the sites are not satisfied, operation of pump becomes hard. In this case, the Team requested them to change the site.

For instance, the group No.4 in Viziwaziwa and the group No.1 in Mwanabwito changed the sites due to following reasons.

Group No.4 in Viziwaziwa : There are three Kisima in the site as water sources for vegetables. However, water depth is only a few centimetres, which shall be dried up easily within a few months. Also distance between the water source and the farm is 70 m that has gentle slope toward farm. Therefore the Team recommended constructing some Kisima for water source. According to the members, their area is located in a relatively lower place, so that water will recover in a day. And they construct some Kisima to keep more water than now, and cultivate some land near the Kisima. We accepted them to be members after cleared the above condition.

Group No. 1 in Mwanabwito : Their farmland is located 100m away from water source with a gentle slope. Therefore we requested to change the site.

After above investigation, following items ④ to ⑦ were explained and discussed in workshop with

the study team. The study team, DSMS or village extension officer normally explain the situation, then discussion was held among members. Final decision was made by the group members after one or two weeks. During the period members discuss among themselves.

④ **Choice of pump type**

Two types can be considered, one in Viziwaziwa and another in Mwanabwito and Ruvu Darajani. The former cannot extend the cultivated land because of limited water source, such as Kisima, however, the latter can do because the water source is Ruvu River.

First of all, expenses and advantages of pump were explained by DSMS in the workshops. The expenses included initial cost and maintenance cost. Furthermore, disadvantages of pump were explained, especially in Viziwaziwa where cultivated area under irrigation cannot be expanded because of water source. And efficiency of watering by plastic container is considered to be the best. Therefore, an area might be reduced when using pump because of low efficiency. Therefore, treadle pumps were chosen in Viziwaziwa.

Viziwaziwa (Treadle pump)

In Mwanabwito and Ruvu Darajani, there is the river as water source, therefore cost was main theme. According to the members, this is a first trial for them to grow vegetables under watering. And if there were good results, they would want to extend their land. Therefore, engine pumps were chosen for both villages.

Demonstration at Mwanabwito

⑤ **Storage of pump**

A pump, a water tank and a hose are the important properties and they pay attention to them for safekeeping.

For example, members thought that they would keep a pump in a temporary house near the vegetable field in dry season when water level goes down while staying in the house. In the workshops and the field investigations, the storage site was changed from temporary house to their residence on the plateau.

In Ruvu Darajani and Mwanabwito, the residence is located near their farmland.

⑥ **Irrigation method**

Irrigation method is an important factor that affects the running cost and the size of cultivable land.

Members, who are going to use an engine pump, considered to adopt a following way to minimize the running time of pump. They fetch the water from the river using pump, into water tank located in/near the farm land through a hose. From a water tank, water is distributed directly to vegetables by plastic container. This method has been carried out in Viziwaziwa and seems to be the most efficient way to minimize the amount of water.

In Viziwaziwa, water will be applied directly to the vegetables from Kisima using a treadle pump.

⑦ Decision of a type of water tank

Discussion making of a type of water tank was as follows. Firstly the members selected several types which they saw and heard before. After that advantages and disadvantages were discussed at the workshop. Final decisions were made after one week of the workshops. A plastic water container was adopted by Mwanabwito's group and an earth tank by Ruvu Darajani's group. The capacity of the plastic water container is 200 litres.

The following three types were discussed in the workshops.

Type	Advantage	Disadvantage	Remarks
Earth tank	It is the cheapest and easy to construct. Capacity can be vary easily according to demand.	Efficiency is low because of percolation. Farm land is located in the flood plain, therefore tank must be reconstruct every year. Because mud is piled up in rainy season in the tank.	Ruvu Darajani adopted this type because of cost.
Cement block Including concrete lining for earth tank.	Percolation can be prevented. Therefore efficiency is good.	Mud will be piled up in rainy season as same as earth tank. When large-scale flood comes, structure would be washed away by it.	A lot of members wish to adopt this type when we asked at field survey. After finding out damage by flood, no member adopted this type.
Ready made （Plastic, water can）	There is no leakage of water for this type. It is possible to carry from field to house. Therefore tank can be used for domestic water in rainy season applying water from rainfall.	Big capacity of this type is expensive and heavy. When small capacity of this type is used, running period becomes short and running times become increased. Temperatures of water become high in case of keeping water in tank long time. A water can is too heavy to carry and easy to rust.	Member in Mwanabwito adopted plastic container because of easy to carry. Capacity is 200 litres. One group requested three of them.

In case of an earth tank adopted in Ruvu Darajani, it is necessary to reduce percolation and to minimize water loss. Ramming down soil on bottom of the tank would reduce the percolation. However, if there is a lot of loss of water, lining with cement or plastic sheet will be considered against the percolation.

Water Right

Water right must be obtained for using river as water source. Steps for obtaining water in right in this study are as follows.

① Collecting information: We visited Central Water Board Unit to ask about water right at first field survey carried out March 2001. We explained about summary of our project at the moment. According concerned officer, we must apply water right after making clear about site and amount of water use. Therefore it was decided to apply water right officially at the stage of second field survey.

② Application of water right : Water right was applied after fixing the site, irrigation method and amount of water use at this field survey (Second field survey). Chairman of pump group filled in the form collaboration with DSMS. Members provided application fee, which is 35,000 TShs.

②-1 Field trip by concerned officers: The officers visited both Ruvu Darajani and Mwanabwito (group No. 1) at first. In Ruvu Darajani, chairman of pump group accompanied and got explanation about water right from officer. In Mwanabwito, DSMS explained about water right to members instead of officer following day. After field trip, officer said that amount of water use is very small, therefore there is no abstraction to get water right. However water right must be obtained from groups whose intake facilities should be less than 200m at the distance. It means that every group must get water right where intake facility is located more then 200m from another intake. We requested to officer that one village can get one water right for every groups instead of five water right because of amount of water use and expenditure of application fee. Amount of water use is very small due to irrigation method and land size. And group cannot afford application fee (35,000 TShs) in case it is applied for each group.

②-2 Discussion with environment officer: Following three matters were pointed out by environment officer of Central Water Board Unit when we submitted application form. (1) It is prohibited to utilize land within 200m at the distance from riverbank. (2) It is necessary to take counter measure to avoid chemical pollution. (3) It is necessary to not effect quantity of water. Therefore application form was submitted later with documents including following contents. (1) This rule is to avoid sedimentation caused by erosion. Therefore we explained that vegetation will not change for our study. It means that sedimentation will not be increased by our project. (2) Irrigation method adopted for both sites, is using water container. It means that all of water applied for vegetable is consumed by vegetables and vertical percolation. Therefore water runoff on surface with chemical should be negligible. (3) Amount of water use for this project is very little, therefore it should be no effect about quantity of river water.

These documents were made by DSMS, DALDO and RAA.

②-3 Acceptance of application: Judgment on application is delivered almost every three months by the Water Board. However the exact time of this judgment is delivered is not

sure. Therefore, Water Board issued temporary water right, and then we started the project.

1.2 Repayment Schedule

The workshops were held with all pump group members at all sites in the middle of January to discuss the schedule of repayment to CPMU for pumps and accessories based on the agreements. According to the first agreements, all of them should have completed the repayment of the first year (2001 to 2002) by the end of March 2002. But mainly due to the drought conditions during short rainy season, members requested the JICA Study Team to reschedule the repayment in workshops. The details are indicated on the tables below.

1) Date of Workshops

Site	Viziwaziwa	Mwanabwito	Ruvu Darajani
Date	1/15(Tue)	1/16(Wed)	1/17(Thr)

2) Reason of Reschedule

Site	Viziwaziwa	Mwanabwito	Ruvu Darajani
Reason	Some farmers can not get any harvest, while others expect lower harvest, due to drought.	1. Low harvest is expected because farmers are not accustomed to grow vegetable during short rain. 2. The arrangement for pump use was delayed. 3. Pests attack did damages for their crops. The low harvest will be used to purchase input for next crop.	1. Low harvest is expected because farmers are not accustomed to grow vegetable during short rain. 2. The arrangement for pump use was delayed. 3. Pests attack did damages for their crops. But they decided to pay 40% by the end of April.

3) Date of Repayment

Item	Viziwaziwa		Mwanabwito		Ruvu Darajani	
Repayment Years	1 & 2		3		3	
No. of Installments	4		12		5	
Period (Start, End)	7/9	7/30	8/1	10/17	3/31	10/31
Date	7/9, 16, 23, 30		8/1,8,15,22,29, 9/5,12,19,26, 10/3,10,17		3/31, 4/30, 8/31, 9/30, 10/31	
Note	Every Tuesday		Every Thursday		End of Month	

4) Amount to be Repaid

Item	Viziwaziwa		Mwanabwito		Ruvu Darajani	
Number of Member	Imarisha	3	All	5	All	5
	Umoja ni Nguvu	4				
	Yatima	3				
	Mwanzo Mgumu	5				
	Nguvu Kazi	2				
Total Amount	Imarisha	189,740	All	688,860	All	594,610
	Umoja ni Nguvu	201,120				
	Yatima	201,120				
	Mwanzo Mgumu	201,120				
	Nguvu Kazi	201,120				
Amount in 2002	Imarisha	189,740	All	229,620	All	198,200
	Umoja ni Nguvu	100,560				
	Yatima	100,560				
	Mwanzo Mgumu	100,560				
	Nguvu Kazi	100,560				
Payment/Installment /Person	Imarisha	15,812	All	3,827	All	7,928
	Umoja ni Nguvu	6,285				
	Yatima	8,380				
	Mwanzo Mgumu	5,028				
	Nguvu Kazi	12,570				

Although the JICA Study Team accepted the postponement of the schedule for the first year, members also agreed to discuss again for the repayment schedule of the remaining amount for the 2nd and 3rd year. Besides the above reasons, there is a possibility that the members strongly believe they can repay only after the long rainy season, the period when members used to own a certain amount of cash.
Members also decided to pay savings and emergency insurance providing for running costs and accidents. Details such as the amount and timing of repayment are being discussed among members.

5) Repayment

No group has reached the amount to be repaid so far because their crops were submerged due to the serious flood in Ruvu Darajani. But their attitude was very favourable as they started to repay from February 2002 that was one month earlier than the due date.

Repayment by each Group at Ruvu Darajani (TShs)

Name of Group	Total Amount to be Paid	Amount to be Paid as of January 2004	Paid Amount as of January 2004
Mwangozo	594,610	396,400	146,985 (37 %)
Nguvu Kazi	594,610	396,400	308,415 (78 %)
Juhudi	594,610	396,400	262,490 (66 %)
Jifunze	594,610	396,400	95,515 (24 %)
TwendePamoja	594,610	396,400	107,846 (27 %)
Total	2,973,050	1,982,000	921,251 (46 %)

There were some gaps between groups but all the groups have an intention to repay after next harvest. The pump groups in Ruvu Darajani started to plant with the input from the revolving fund, and the

proper yield for repayment was expected. Each group made its planting plan and reported it at the meeting for all the pump group members. Based on the plans, they discussed how to make production of this season better and made some suggestions to other groups' plan one another.

In case of Mwanabwito, only three groups paid: i.e. Juhudi TShs22,000.-(7.4%), Mshikamano TShs20,000.-(8.7%) and Umoja TShs187,000.-(8.7%) until November 2002 while each of them must pay TShs230,000.- annually.

Reasons of low repayment rate in Mwanabwito seem to be:

- Decrease of members in a group
- Scattered individual farm plot making pumped irrigation difficult for each group member
- Effect of the serious flood in March
- Lack of farm input and low horticultural technology
- High market cost
- Small farm plots

Furthermore, some members still consider that this project is a donation and it is not necessary for them to repay their loan.

In case of Viziwaziwa, there is no repayment of treadle pumps so far. It is understandable since they have not used for long, except a short period after the pump came to their plots. The pump had better be taken away from the farmers who do not use it and be sent where there is a need of pump in order to find in what circumstance and at which area the pump can be highly used. Treadle pumps were not used in Viziwaziwa caused by the following reasons.

- Two persons are needed to water by the treadle pump; on the other hand one person can perform watering by poly-tank.
- Hoses of the pump are heavy and it is troublesome especially for changing furrows.
- Hoses damage plants during the watering at the time of changing furrows.

C.2 Improvement of Kisima

There are many kisimas that the farmers use as water sources for vegetable farming, which are dug beside farms in Viziwaziwa. It is difficult to dig them deeper as they are made without protective structure. Therefore, it takes a great mass of labour to dig deeper in order to prolong watering period, since huge earthwork is needed to dig beyond a certain depth.

In the Study, the followings were verified.
- Possibility of prolongation of watering period by means of making deeper Kisima.
- Improvement of digging method using cheep material for sheeting.

The farmers dug down kisima 50 cm deeper collaborating with the VAEO in setting wood sheeting. The kisima, which was improved, was almost 3 m in diameter and 2 m in depth.

The Team explained to farmers how to dig down kisima with wood sheeting. Mr. Mohamade A. Mohamed (Viziwaziwa CPMU chairperson) tried to dig down kisima with sheeting in his field first. And he explained to the other farmers about this method.

Improvement of kisima involves earth retaining with wooden frame, which is shown in the picture, and it can perform comparatively easily by increasing the depth of the existing kisima by about 50 cm more. The size of frame was set to 1.0 x 1.0 x 0.5 m (height).

The farmers dug a hole bigger than frame on the bottom of kisima, and frame was made to be settled. The depth was made shallower several centimeters than the height of frame, and when the frame was installed, the frame made it higher than the hole so that mud might not flow in.

Digging the works had to begin eliminating water in kisima first. Although there was yearly difference, the water level at beginning of short rainy season rain was lower than the optimum. This time, since digging was carried out after big rain in mid-January, the water level was high and drain work of water was cumbersome.

The chairperson suggested, that the size of a frame could be expanded to 1.5 m. The size can be decided according to the needs of farmers. However, most of the farmland for the group members was hired one. Therefore, even though the surrounding farmers have acknowledged its functional convenience, they are reluctant to improve their Kisima, since most of the farmland is hired.

C.3 Watering with a Longer Interval

The farmers in the Study Area are using polyethylene tanks for watering. The watering is normally carried out everyday. According to calculation done by the Team, it was revealed that everyday watering supplied too much water as the water requirements. Trials were carried out in the Verification Study to find whether watering interval could be prolonged. As a result, it was observed that the vegetables grew properly even with watering every other day as long as the temperature was not extraordinary high. Subsequently, there appeared farmers who practiced watering twice every three days in the final year of the Verification Study, and they got a proper yield.

Experiment for Watering Interval

1. Purpose: Even if watering is a very hard work, the Team observed in a farmland that farmers would supply more water than needed (about 15 mm/time). If over supply of water could be verified, the Team would propose to farmers an effective use of water.

2. Plot: at Mr. Mohamed A. Mohamed farm in Viziwaziwa village.

3. Crop: tomato

4. Plot condition:
   3 plots, each plot has 10 m length and 1 m width.
   Setting conditions
   - Plot 1 a usual watering interval, one watering per day.
   - Plot 2 half of the usual watering, one watering every two days.
   - Plot 3 one third of the usual watering, one watering every three days.

5. Result of observation
   The experimental plots were set up and transplanting was carried out at the beginning of December 2001. This examination was carried out in order to see whether watering interval affects yields of tomato. Therefore, manure and agricultural chemicals were applied for all plots in equal quantities that are equal to those used in the input credit project.
   The growing situation on January 18 2002 is shown below.

The growing situation observed in early January showed that plot 1 (everyday watering) was better than the other two. However, in the observation of the late January, the plot 3 (watering every three days) being the worst of all, the difference between the plot 1 and the plot 2 was not significant. A comparatively big rainfall fell in the meantime, and the plot 2 recovered in response to this rain.

In the observation of the late January, high temperature constraints were observed in every plot especially in the plot 2. In the observation of mid-February, these constraints were spread to all plots.

It is investigated whether effective use of water and curtailment of labour force would be possible by reducing simply the number of watering. It is difficult in this examination to determine an optimum consumptive water use for crop. However, the examination shows that the growing situation between the plot 1 and 2 were not much difference and the shortage of water could be covered by one big rain. The farmer of the plots showed an interest in the study and told the Team that he would try in some plots the interval watering in the next season.

The Team recommended farmers the same examination might be succeeded by themselves in normal farmers' field in order to grasp the proper amount of watering in the fields. In addition, as VAEO, having worked together with the Team, understands the purpose, the method and results of the examination, he can help the farmers to try the interval watering.

C.4 Investigation for Development of Water Sources

4.1 Site: Viziwaziwa village

4.2 Purpose:

In the dry season, it is not easy to secure water not only for agriculture but for domestic uses especially in the concerned area where huge deviations in rainfall are observed. In Viziwaziwa village, although shallow wells (commonly called kisima) are mainly used as water source, there are few such wells that can secure sufficient amount of water through the year. Moreover, since the rain started late in this short rainy season and did not provide sufficient water, the water level in kisima dropped drastically. Villagers advanced many requests for water source development due to such a situation. This investigation examines the type of possible water source development, including source other than kisima.

4.3 Investigation Result

1) Period: 22nd, 23rd and 24th, Jan. 2002

2) Outline: The investigation mainly focused at places the VAEO and villagers commonly called ponds. About eight such places are shown in the location map, which are numbered. The outline of each place is shown in the following table. Most are shallow wells, although they are generally called ponds as shown in the table. This area is lower than the surroundings geographically speaking, and inflow of water, such as stream, is not seen. It seems that water almost dries up in the dry season, and places are used as paddy fields in the rainy season. Although the catchments area[1] of Ngelen Gele pond, which was used before as water source for Sisal Estate exceeded 100km^2, other ponds are as narrow as 1-2km^2. In the case of the Viziwaziwa pond, outflow as surface runoff has not been seen during long rains for three years. For Ngelen Gele pond, parts of a recent embankment have collapsed, making it not functional. In addition, there are many beneficiaries for Viziwaziwa pond, as 300 houses use them for domestic water use. Since a field is located on the outskirts of a pond, 10 beneficiaries use them for agriculture.

[1] Catchments area is estimated on the basis of 1/50,000 of topographical maps.

No.	Site	Outline	Remarks
I	LUGOLOGOLO Pond	There is no water presently. Although a shallow well is located in the upper end of the pond, water was not seen in the well. The depth of the well is about 2m. Now, farmers are ploughing as preparation work of the paddy field for rainy season.	
II	VIZIWAZIWA Pond	This pond is located near a primary school and houses, which have most beneficiaries. The number of farmers using this pond for agriculture is ten houses, and for domestic use about 300 families. There is no water in the pond now, and the water of a kisima dug in the pond is used. The road is improved on the lower reach of the pond, and if used as an embankment, it can be big in capacity. However, in the present condition, road cross culvert for drainage was constructed, therefore the bottom of the culvert becomes a high water level for the pond, which has very small capacity.	
III	Pond	Although it becomes a pond in the rainy season, there is also no water, and the preparation work for a paddy field was going on. There is a kisima, called a spring in the area. This kisima does not dry up through the year. However it cannot be used as water source for agriculture due to capacity constraints.	
IV	SAGALI KAMBINI Pond	There is some water in lower parts. Moreover, it is guessed that comparatively long term water is stored because of swamp. Cultivation of vegetable is observed.	
V	MUAZAUZA Pond	Preparation work of a paddy field was seen at I and III at the time of investigation.	
VI	Tube Well	It is the site where the hand pump was installed. A pump is not installed now but water of kisima is used.	
VII	Shallow Well	The well improved with concrete is not used now. A shallow well is dug at about 30m from the well, and the water is used. The depth is about 2.5m.	
VIII	NGELENGELE Pond	In this investigation, there was abundant water. This is the pond used by estate for sisal production before. Most of the embankment remains, however one part was washed away. Those days, water was pumped up from the pond with an engine pump, and delivered to the fields through pipelines. About ten farmers use now this pond, which is mainly used in the rainy season, and there are also farmers who irrigate with an engine pump. According to a farmer, water shortage dose not occur through the year.	

4.4 Future Subject:

Viziwaziwa depends on kisima mostly. A kisima is a shallow well 2 to 3 m in depth. It is dug for every field to provide water for agriculture, and also for domestic use.

This investigation was undertaken in order to examine the possibility of water source development other than kisima. It reconfirmed that kisima is a method for water supply suitable for the area from

the viewpoint of effective water use.

Namely, it is not easy to store surface water because of small catchments and sandy nature of soil. Moreover, in order to use little water for agriculture, as a method of making minimum loss, irrigation by bucket is optimum, and the labor involved increase in proportion to the distance from water source to crops. Therefore, water source for every field can also shorten conveyance distance. Moreover, if dryness progresses, it will also take time for the water level of kisima to recover. By making the area per kisima small, recovering time also becomes short and efficient use is possible for conveyance. Since the water-surface of kisima is small, it has the advantage of reducing the amount of evaporation.

When a water source different from kisima is considered for the area, two proposals can be formulated. One would be to store by enlarging capacity of existing pond in Viziwaziwa. The other would be to repair the embankment and using it as a water source.

(1) Viziwaziwa Pond

1) Outline

The maintenance of shallow pond like Viziwaziwa pond would require to remove the earth and sand deposited in the pond, and to secure capacity. It is difficult, when the following conditions are taken into consideration, in order to improve this pond as reservoir.

- In order to secure the safety of embankment, width of embankment needs to be fully secured making amount of soil for construction large.
- It is important to choose suitable banking material. Moreover, safety of embankment is not securable unless compaction is fully performed.

Thus, amount of soil for construction becomes large. Moreover, if banking material cannot be gotten nearby, cost of construction will become expensive.

Therefore, in order to secure the capacity of the pond where earth and sand will flow every year to reduce capacity, a method of removing deposited earth and sand periodically is suitable.

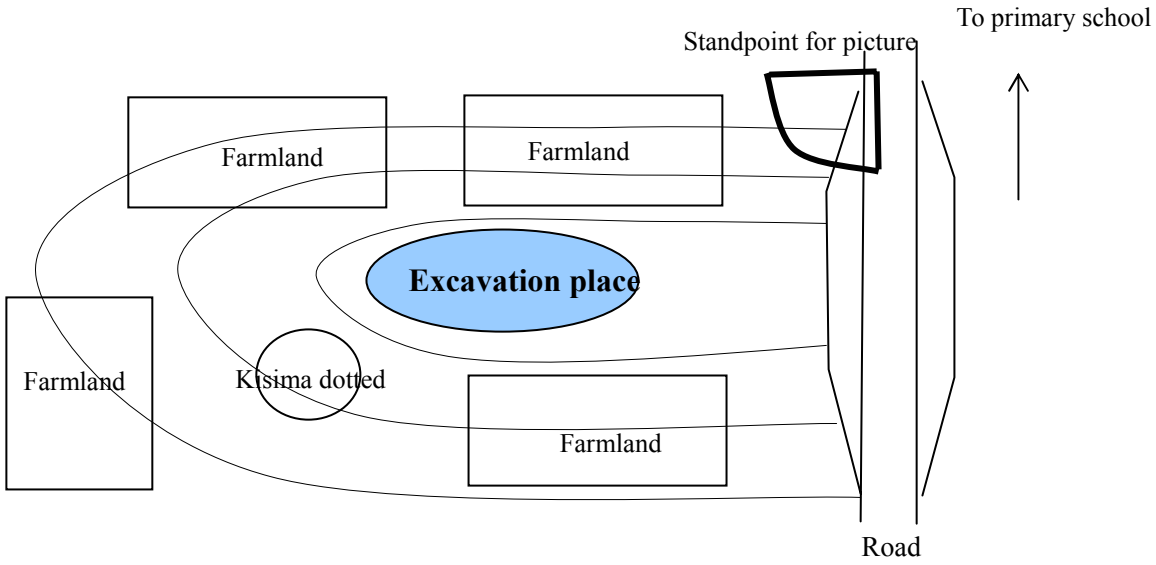
2) Maintenance

If the amount of inflow earth and sand to pond is set to 30t / ha year, the amount of yearly deposition will become as follows.

120 ha (1.2 km^2) x 30 t = 3,600 t = 2,000 m^3

Therefore, the amount of deposition removal of every year is presently set at 2,000m^3. This can protect against reduction of the capacity by earth-and-sand inflow.

The use situation of the present pond considers a part used as farmland, and a part used for kisima, as shown in the following figure. As shown in figure, it is better to avoid excavation between for farmland or near kisima. In addition, since the digging range is 100mx50m, a depth of 40 cm is considered.



3) Use plan of a pond

Since there are few inflows a year, even if sedimentation is removed amount of water does not increase drastically. Therefore, it would be difficult to increase the present number of beneficiaries. After removal of sedimentation, capacity of pond become slightly large, and it is expected that the term for water supplies to kisima becomes longer than present.

Since the quantity of water, which can be used for agriculture, does not increase as mentioned above, irrigation by the bucket is recommended.

4) Use of sedimentation

The farmland around the pond is sandy soil. Since sedimentation provides a lot of organic matter, it is desirable to return it to the near farmland and to use it. This makes conveyance distance of the digging ground short. However, sedimentation put in the farmland needs to be made not to flow again. Followings can be considered as protection of soil loss. It is expected that the inflow of earth and sand to a pond decrease also in the long run with this.

Water erosion protection: terrace channel, sedimentation tank, bench terrace, etc.

Water erosion protection farming: contour farming, mulching, etc.

In above-mentioned, soil erosion can be decreased by combining terrace channel, contour farming and

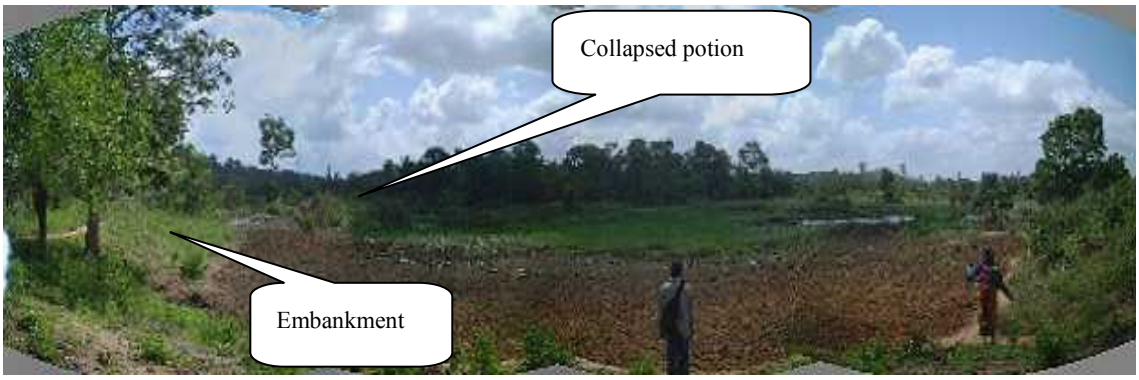
mulching. That is, terrace channel is prepared in the upstream side of farmland, and inflow of surface water is prevented. Furthermore, making a ridge along with a contour line prevents outflow.

(2) Ngele Gele Pond

1) Outline

The embankment is washed away is a portion which touches the natural ground on the right bank. Grass has grown thick now on the site since about 20 years or more have passed. However most of the embankment has not collapsed and is not damaged.

Therefore, the irrigation pond can recover its original function by repairing the collapsed part. Other structures, such as spill way and intake works, have not been observed. Therefore, it is guessed that spillway was installed in the collapsed place.

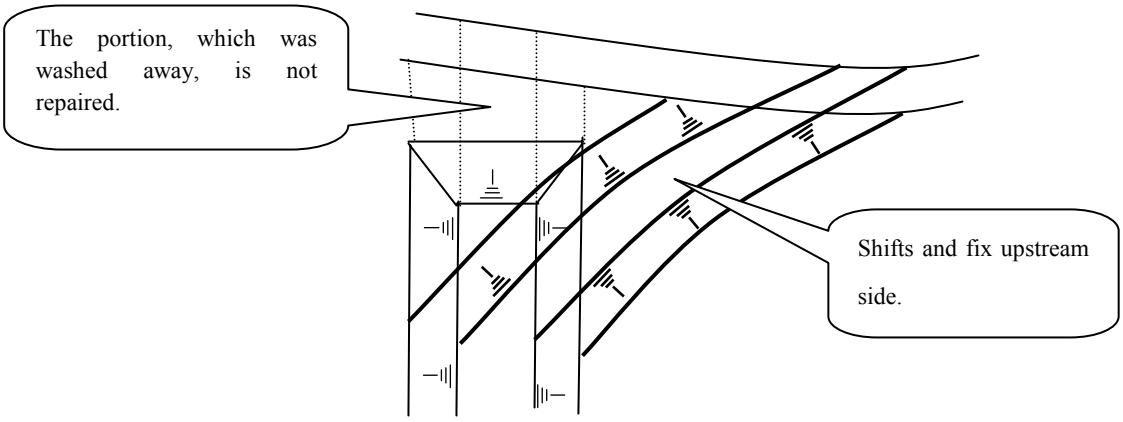


2) Contents

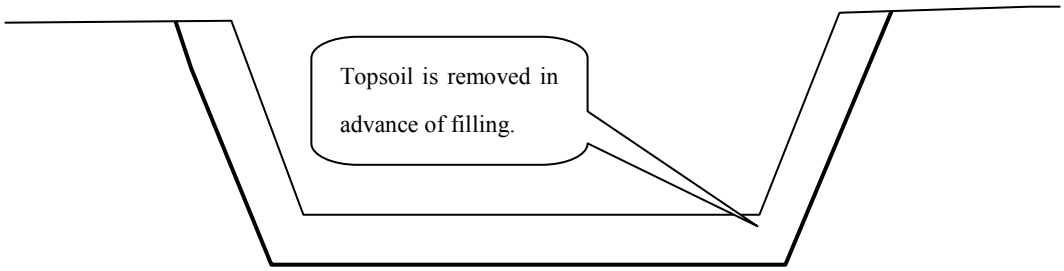
In rehabilitation, repair (banking) of embankment and installation of spillway are necessary. Here, the point, which should be considered in maintenance, is as follows.

(i) It is better not to raise the embankment with fill in the collapsed portion again, but to shift position, since it is expected that the said collapsed portion, is weaker than

other portions. That is, the repaired part of embankment is shifted and carried out upstream from the collapsed part. (Refer to the following plan)



Moreover, before filling a part 30 to 50 cm of topsoil need to be removed first. In addition, topsoil needs to be similarly removed from the portion, which touches the existing embankment and a natural ground. (Refer to the following section)



(ii) Spillway

A spillway is required to secure the safety of embankment. A flood should not over flow through the embankment but through the spillway. A spillway should be built on the untouched part of embankment, not on the repaired part which is new. In building the spillway, it is important to reduce flow velocity so as not create erosion in time of flood

The maximum allowable velocity is determined based on the lining material spillway as follows.

Material	Maximum Allowable Velocity (m/s)
Sand	0.68
Sandy loam	0.90
Loam	1.05
Clay loam	1.35
Soft rock	3.00
Concrete	2.25

In order to hold the flow velocity below the above velocity, the spillway bottom slope needs to be smooth, so that flood can be discharged safely. Although it is expensive, lining by concrete needs to be performed, if appropriate velocity cannot be secured in a waterway.

3) Use of pond

By repairing the embankment, enough capacity will be secured. However, it is difficult to always supply irrigation water downstream because inflow is only in rainy season. Therefore, consideration should be given before increasing the present benefit area, increase should be done gradually based on water availability.

(i) Upstream

Presently, vegetable cultivation is performed around the pond. As for the irrigation method, use of a bucket or a small engine pump is recommended.

(ii) Downstream

It is possible to increase the amount of water supplied to kisima, and to lengthen the cultivation period of vegetable. From pond, irrigation by gravity is also possible. Since irrigation by gravity use more water, it is necessary to take that into consideration in a plan.

(iii) Fish pond

A pond can be used positively as a fish culture pond. A site with small fish was observed at the time of investigation. Since water can be secured through the year, it is also possible to use the pond as a fish culture pond in addition to agriculture.

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C.5 Improvement of Watering in the Revised Master Programme

Summarising the effects of the Verification Study on this micro project, they brought about the following outcomes; such as increase of possible watering area with reducing the labour; acquisition of agricultural technology through the extension officers who have became more intimate; abatement of structural poverty through group activities; materialisation of year round watering using pumps; and so forth. Additionally, the positive interaction with other micro projects was observed.

As a means of improvement of crop watering based upon farmers' initiative that the farmers are able to carry out by their own capability with the collaboration of district officers, watering using small pumps in groups is proposed. Additionally, watering with a longer interval that enables water saving and labour reduction is also proposed. These possibilities were acknowledged through the Verification Study.

As a result of the Verification Study, the followings were ascertained to be taken into consideration for implementing this programme.

- Engine pump is effective, providing that water source is perfectly secured. However, some more conditions are needed to make this programme to be successful. The conditions are farm input shall be properly prepared, the group members are honest to work together and leadership shall be strong.
- The farms of the groups shall be located at one place, and the groups can monitor progress of cultivation and yield, and income and repayment for the pumps one another.
- Treadle pumps shall be recommended for limited water sources with small amount of water, since engine pumps are too big in capacity. In this case, there is a possibility that using treadle pumps acquires more time and effort on watering than using polyethylene tanks. Therefore, it is better not to use the treadle pump directly for watering crops. When the treadle pumps are introduced, they shall be applied for such case as watering crops at farm far away from the water sources. In this case, a reservoir shall be made between the source and the farm, and the water shall be conveyed to the reservoir by the treadle pump. Subsequently, the crops are watered using polyethylene tanks. For introducing this method, even for small-scale facilities, once permanent ones are included in the project, the land ownership shall be grasped before planning, since the problem of land ownership arises.
- It is necessary to take flexible measures as changing watering interval to everyday or even more when the temperature is extraordinary high.

ATTACHMENT

Experiment on Water Consumption

Surface irrigation such as border irrigation was considered as an irrigation method by using engine pump. It is necessary to avoid excess water for reducing fuel consumption. On the other hand all groups planed watering with a plastic container from a water tank. With this method a farmer can apply water looking at the condition of vegetable and save the water.

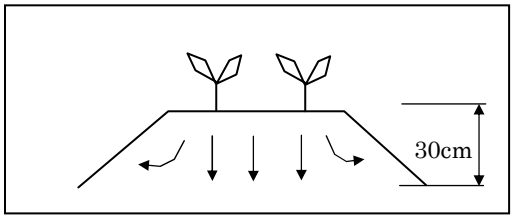
The Team considered the watering with a plastic container is economical because of above mentioned reason, however, amount of water was estimated about 15mm/day in the fields survey at Viziwaziwa. This figure is so big even considering weather condition and soil condition (sandy soil in Viziwaziwa) and about three times more than that of the normal vegetable irrigation.

Excessive irrigation gives troubles both to farmers' labouring and to cultivation. If the amount of watering water could be reduced without any damage to produce, a farmer shall be much free from the hardest work. At the first step, a preliminary experiment on irrigation intervals is needed as a trial and the Team conducted the experiment at Viziwaziwa in February 2002.
Further study will be necessary for this subject as only controlling water may bring labour saving and better production.

Preliminary experiment

At the beginning, preliminary experiment for irrigation interval will be carried out at Viziwaziwa. Three plots of each 5 m^2 are selected there, the first plot being irrigated everyday as they are doing now, the second one being irrigated once in two days and the third one once in three days.

Furthermore bed for vegetable is slightly high. Where bed is high, percolation occurs not only vertically but also horizontally.
This also should be examined through another experiment



Full use of treadle pump

After using treadle pump for two to three weeks in Viziwaziwa, farmers recognized that it could be easy to fetch water for vegetables compared with using plastic container. However they mentioned following disadvantages. ①It takes more time than using container. ②It is impossible to apply water by one person. Because one has to operate a treadle pump and the other a water hose.
These problems shall be cleared through further study.

Estimation of water consumption

Therefore amount of water per plot is

Amount of water / area

=	0.0029	/	0.1256	=	0.0231 m	= 23.1 mm
=	0.0020	/	0.1256	=	0.0159 m	= 15.9 mm

Evapotranspiration are estimated less than 6mm per day. (Refer to master plan)
Excess water are not used for vegetable but only percolation loss.

It is necessary to find suitable amount of irrigation water to avoid the excess water through experiment..

Following experiment are to find suitable amount of water for vegetable through comparing the amount of water.

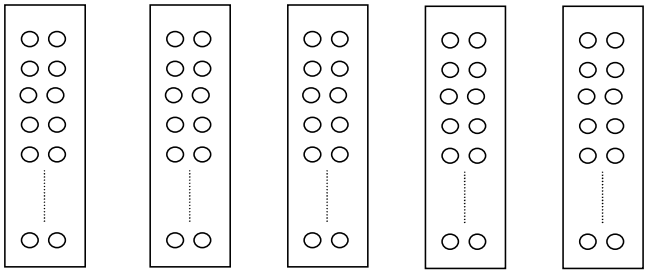
Condition of experiment

Amount of water and interval for experiments are shown in following table. The other condition such as fertilizer, chemical are based on the standard of input

	Watering Interval	Amount of water at one time	Remarks (average consumptive use mm/day)
Case 1	1/ a day	2 liter	15.9 mm/day
Case 2	1/ a day	1 liter	8.0 mm/day
Case 3	1/ a day	0.5 liter	5.3 mm/day
Case 4	1/ 2 days	2 liter	8.0 mm/day
Case 5	1/ 3 days	2 liter	5.3 mm/day

Result

Result will be compared with the amount of output.



Case 1 2 3 4 5