JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF AGRICULTURE AND LIVESTOCK (MAL), REPUBLIC OF ZAMBIA

TECHNICAL COOPERATION PROJECT ON COMMUNITY-BASED SMALLHOLDER IRRIGATION (T-COBSI)

TECHNICAL MANUAL

(Simple Weir Construction and Canal Alignment)

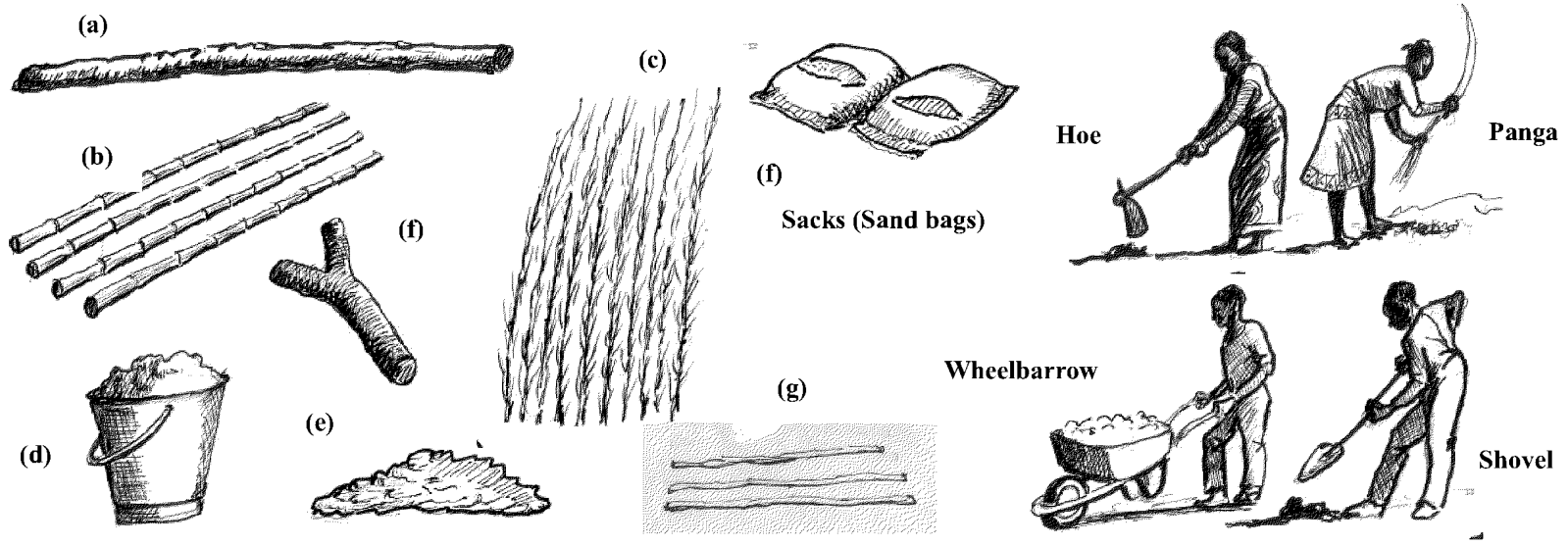
MAY 2015

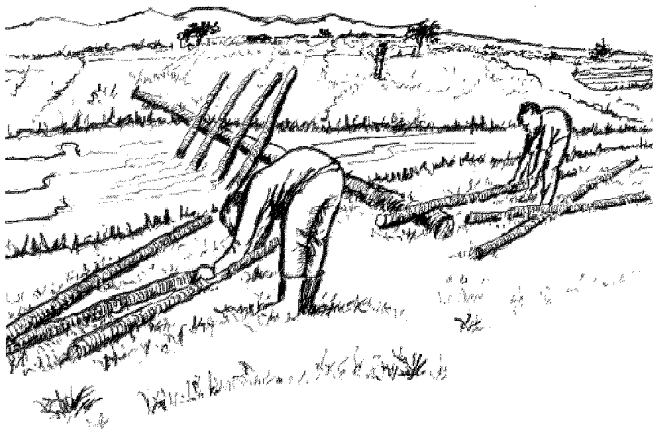
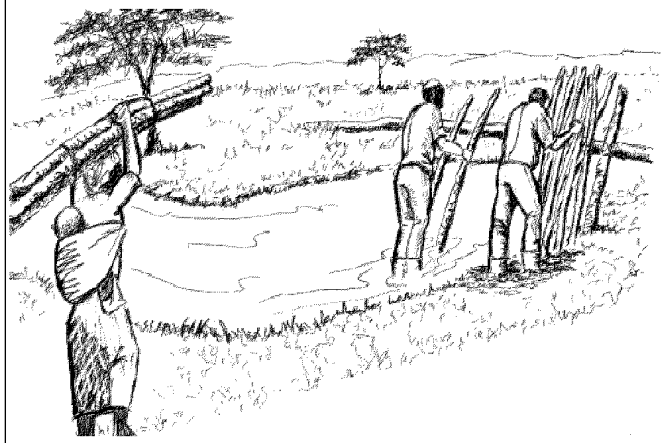
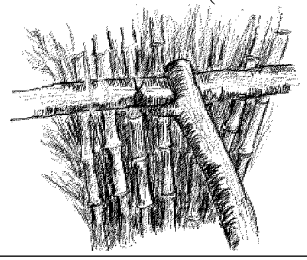
SANYU CONSULTANTS INC., TOKYO, JAPAN

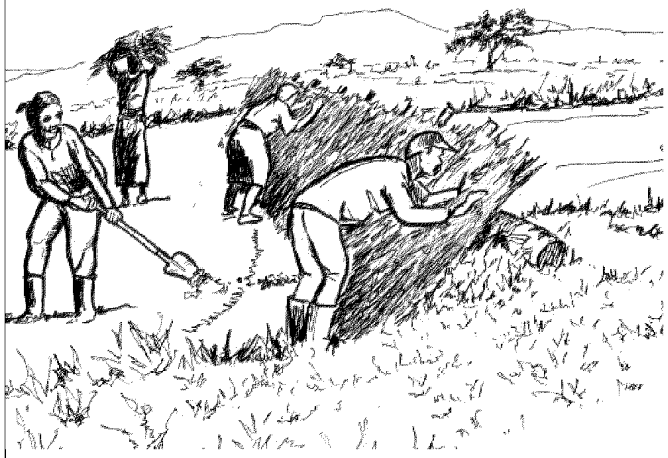
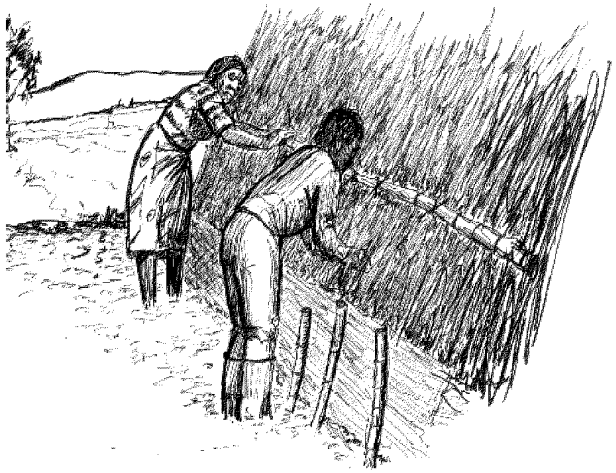
PROCESS DESCRIPTION MANUALS

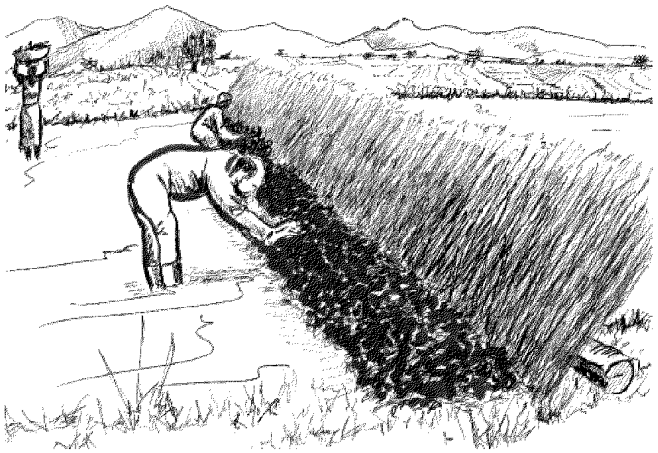
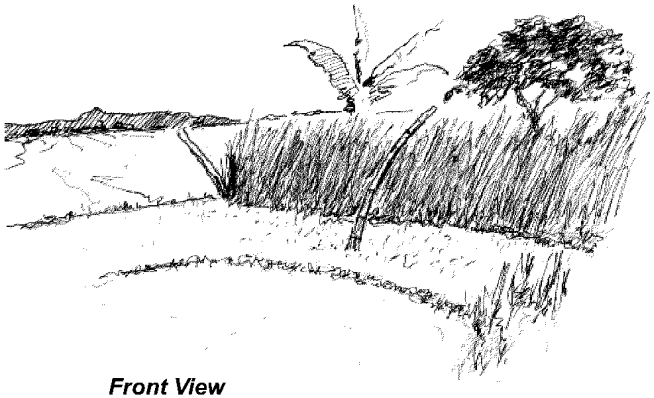
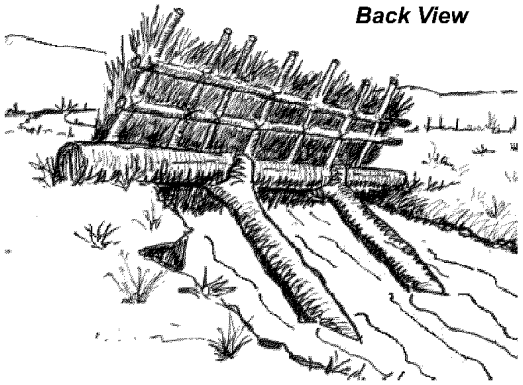
1. Construction of A Temporary Weir: Inclined Wall Type (best suited at narrower streams)

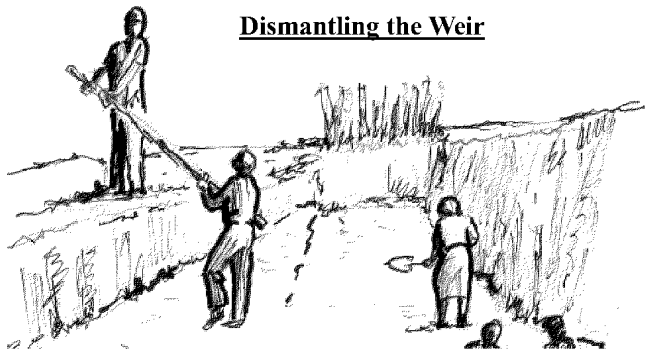
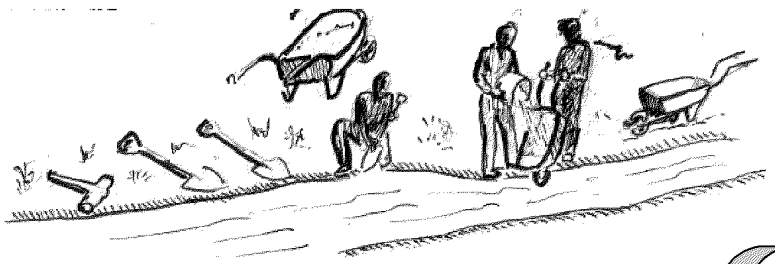
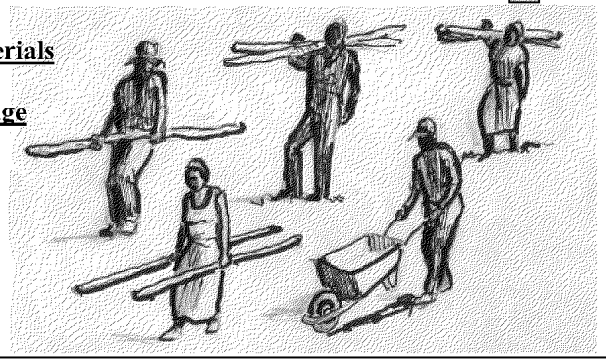
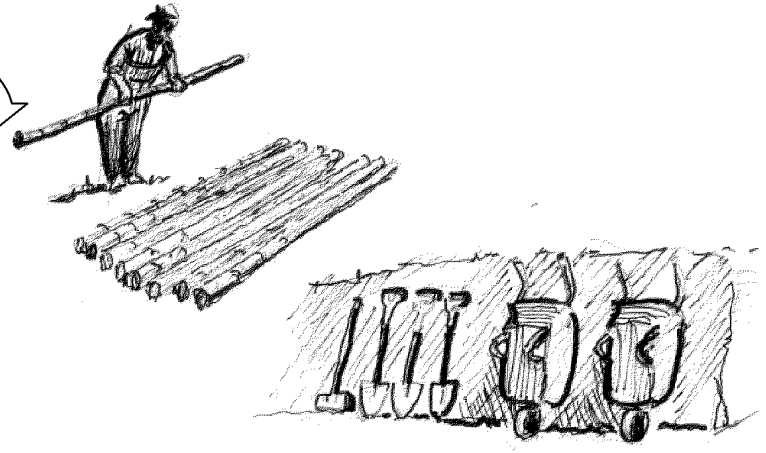
Step	Materials to be collected
0	**Collect all the following materials (refer to the illustration below);** (a) A log: to be put horizontally on the stream bank across the diversion point (Quantity: 1 nos., Refer to Step-1) (b) Bamboo/Twigs: to stand in front of the horizontal log (Quantity: 8 – 10 nos. per 1 meter width of the dam, Refer to Step-2) (c) Grasses (Elephant grass): to be put in front of vertical members (Quantity: depend on the size of the dam, Refer to Step-3) (d) Clay soil: to patch on the grasses. And, if necessary, the clay soil is put in the streambed to replace the sand foundation (Quantity: depend on the size of the dam, Refer to Step-5) (e) Ordinary soil: to patch on the clay soil patched on the grass (Quantity: depend on the size of the dam, Refer to Step-6) (f) Log: to support the brush dam (Quantity: depend on the size of the dam) (g) Creeper: to fix the bamboo/twigs to the horizontal log (Refer to Step-2) **Implements;** Hoe, Shovel, Panga knife, Wheelbarrow, Watering can, Sacks (Quantity of these implements depends on the number of participants for construction of the Dam).



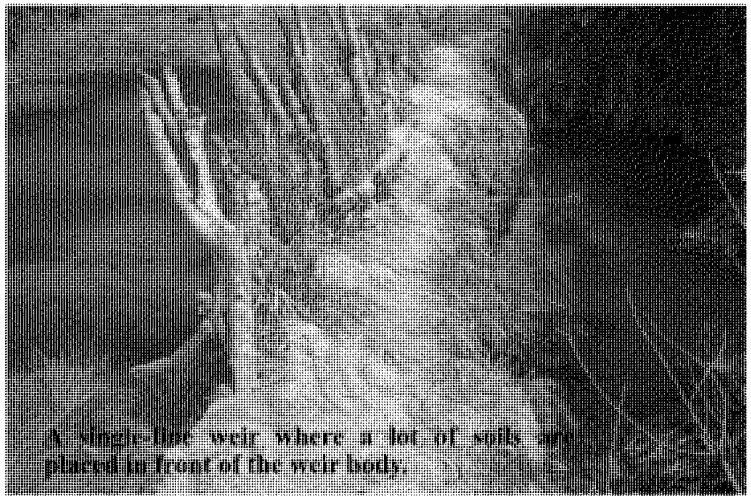
Step	Process	Description	Remarks
1		**<u>Put A Log Horizontally;</u>** Put a horizontal supporting log at the diversion point across the stream. It is advisable that the horizontal log is put on a place where there are tree stump/rock for support of the log. If there are no objects for support, put something such as stone to keep the log from moving by water pressure and weight of the brush dam itself. Length of the log is selected depending on the site condition such as width of the stream.	In case of such site where the material of stream bed is composed of thick sand layer, there is a need to replace the sand layer with imported clay soil. To make replacement work easy, a cofferdam may be constructed using sandbags. If the sacks are not available at the site, banking (soil filling) can be applied.
2		**<u>Stand the Vertical Members;</u>** The vertical members composed of bamboo/twigs are put in front of the horizontal supporting log as seen in the illustration.	To put grasses and soil easily, the vertical members such as bamboo/twigs should be put as close as possible together. These vertical members are placed into the foundation, which in cases has been replaced by clay soil, and again connected to horizontal support log at the top, using materials such as runner (see below). 

Step	Process	Description	Remarks
3		**<u>Placing the Grasses;</u>** Grasses are placed or fixed in front of the vertical members.	To prevent swelling out of grasses, the grasses are bound by horizontal members such as bamboo and tied together with the vertical members as shown in the illustration. 
4		**<u>Pile the Grasses</u>**; Grasses are piled horizontally on vertical standing grasses. See the illustration at the left.	To make the structure less porous to water, the horizontal layers of grass are placed in front of vertical layers of grasses in a criss-crossing way. This pattern helps in making the weir very much water tight. To prevent swelling out of grasses, the grasses may be bound by a vertical member (bamboo) once again.

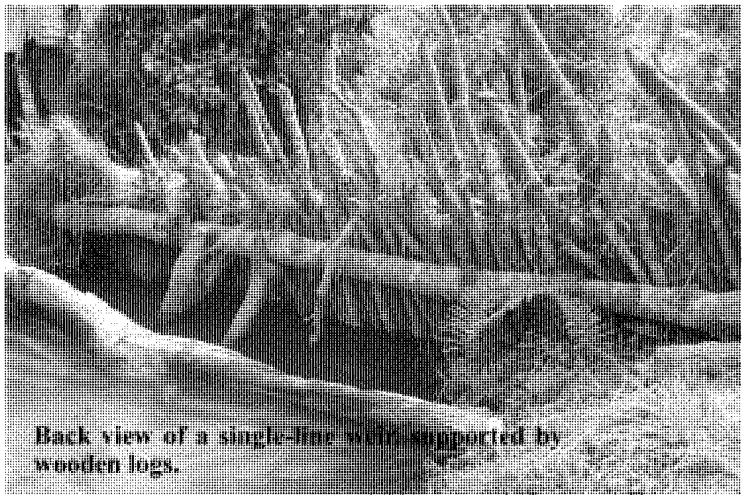
Step	Process	Description	Remarks
5		**Patch the Clay Soil;** The clay soil is patched on the grasses as shown on the illustration in the left hand. Furthermore, to significantly prevent water leakage, the layer of clay soil constructed may be covered by soil existing around the brush dam.	To prevent water leakage, clay soil is patched tightly on the grasses. The clay soil is put not only on grasses as a part of dam but also on the stream banks in contact with the weir to minimize water leakage passing through banks.
6	 *Front View*	**Completion of Construction;** The weir is then completed. See the illustrations in the left hand and below.  *Back View*	**Note; Maintaining the Weir** During operation of the irrigated farming, the diversion weir should be maintained carefully. For instance, if a hole is found at the weir, immediately stop it by sealing with clay soil. This process will restore the weir its former good shape, as the hole will be a source of weakness whereby the structure can fail.

Step	Process	Description
7	**Dismantling the Weir**  **Washing the Tools**  **Transporting Materials and Tools to the village** 	**Note; Dismantling the Weir and Set Aside the Main Materials** These types of weirs are constructed as temporary facility for the intake of stream water for irrigation farming in dry season. Therefore, the weir should be dismantled before the start of the rainy season because such kind of structures are constructed across the river/stream and as such, the diversion weir becomes an obstruction for safety flow of floods. Main materials such as logs, bamboos and twigs are then set aside at a suitable place in the village. If properly stored, these materials will be reused for few years to come. **Setting aside the Materials & Tools** 

Examples of Inclined Weir (Kawambwa District, Luapula Provicne)

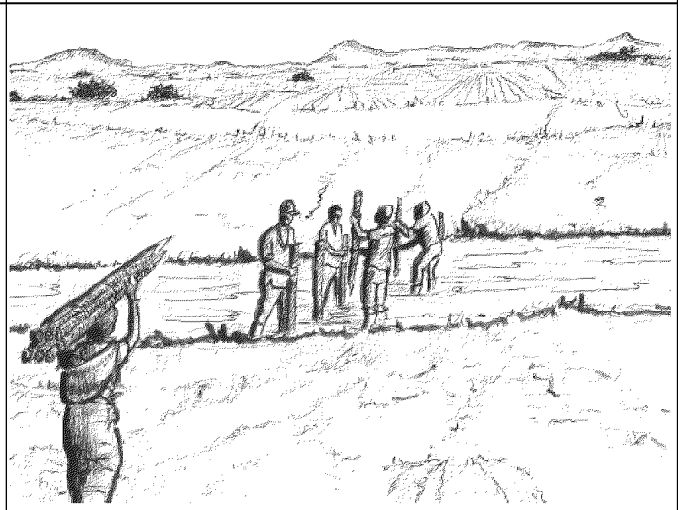
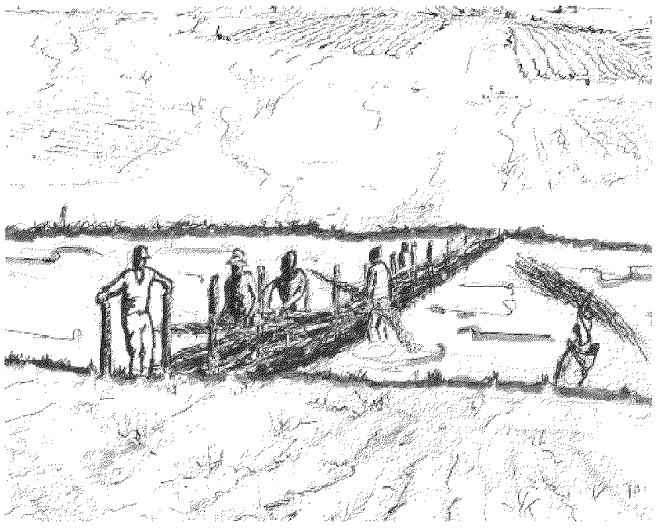
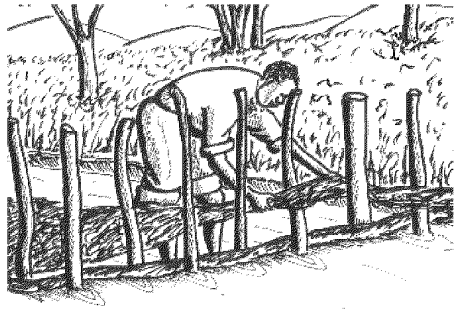


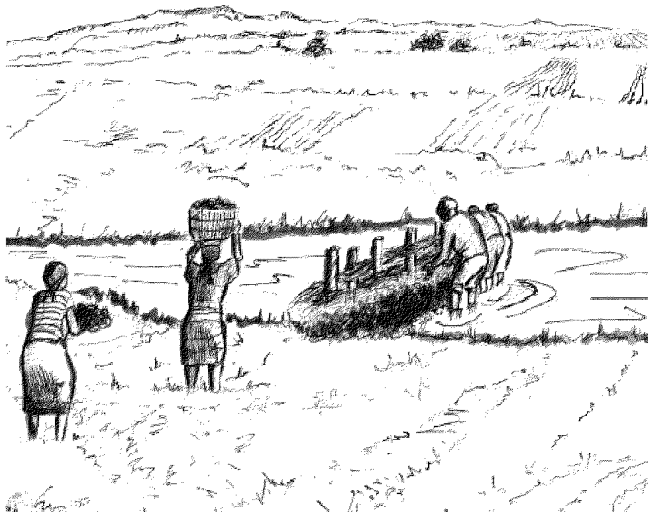
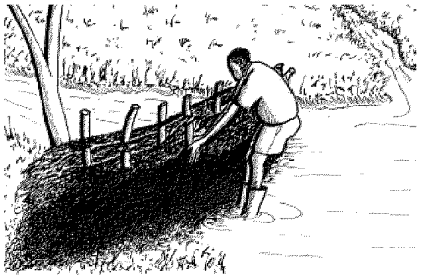
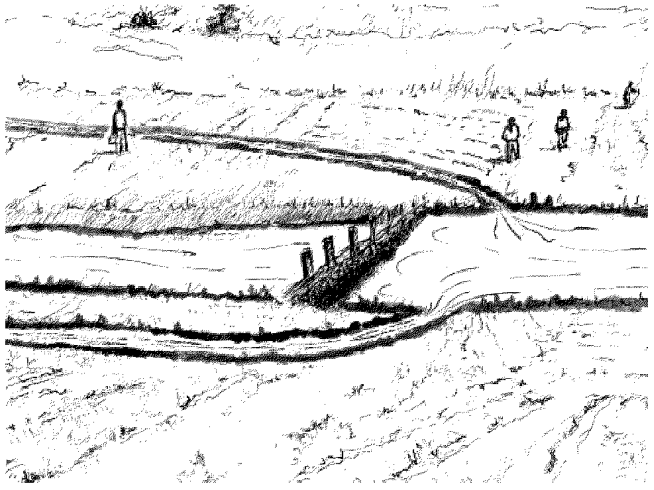
A single-line weir where a lot of soils are placed in front of the weir body.

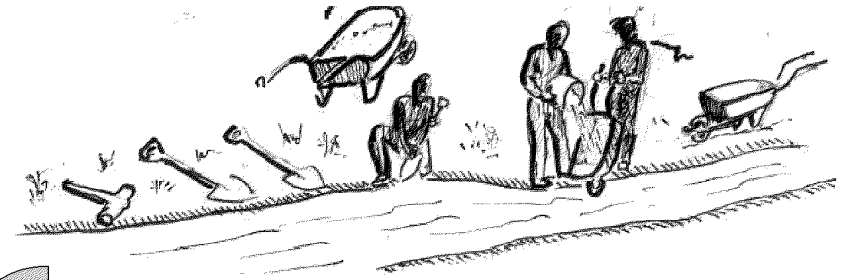
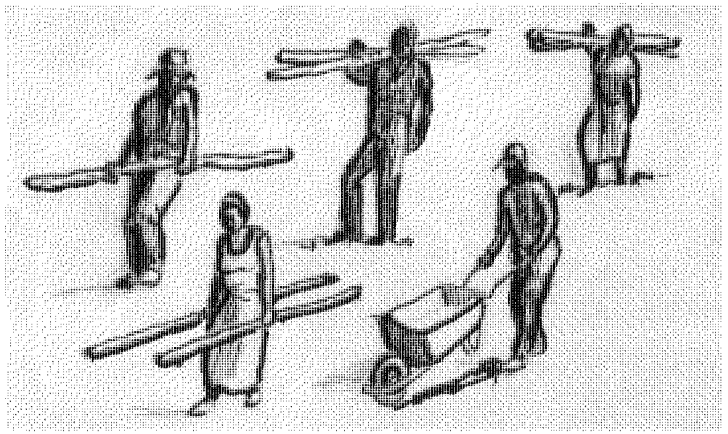
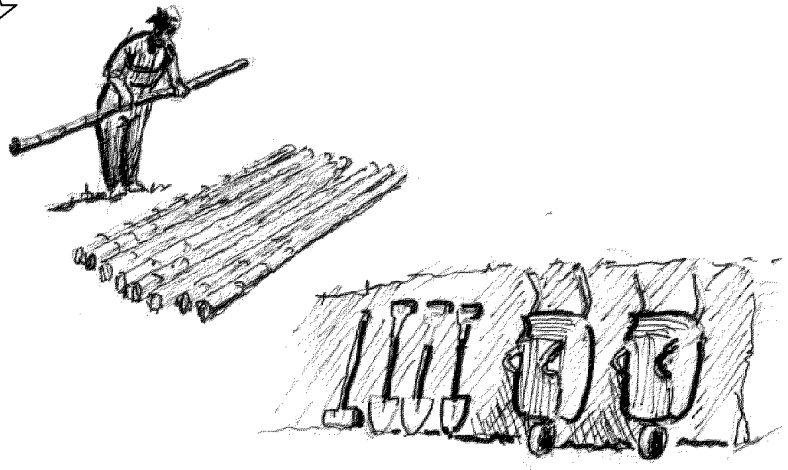


Back view of a single-line weir supported by wooden logs.

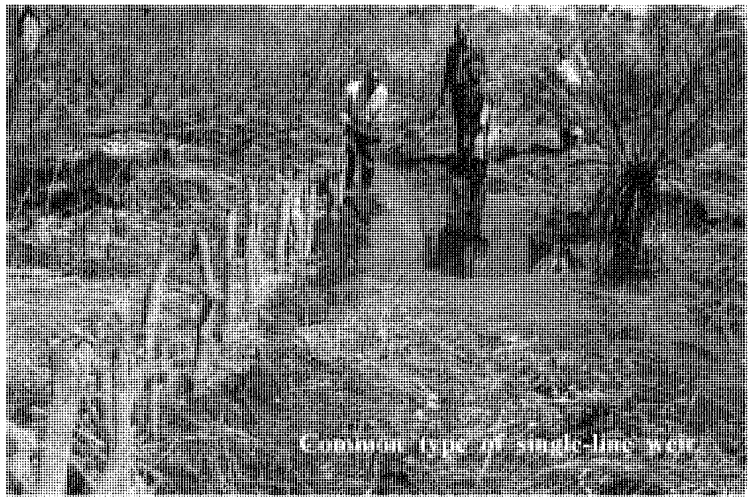
2. Construction of A Temporary Weir: Single-line Wall Type (best suited at wider streams whose foundations are not rock)

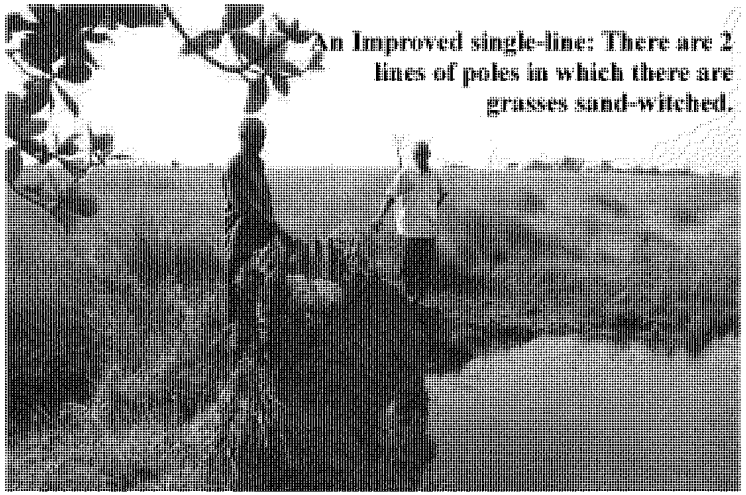
Step	Process	Description	Remarks
1		**<u>Position the Wooden Poles;</u>** Position the wooden poles at the diversion point across the stream with an interval of 20 – 30 cm. In short, there should be 3 to 5 numbers of wooden poles per one meter. The poles are driven into the ground at a depth of more than 0.3m, below soft foundation if any. Length of the pole depends on the site condition, more especially in relation to the design tapping water level.	In case of a certain site in Kasama District, width of the stream at diversion point was about 6m. About 20 wooden poles were piled with 0.2 - 0.3m of interval. Good straight poles with a sizable diameter should be the ones to be used in this step. The hammering of the poles into 0.3 m below the bed level should be done in order to overpass sand foundation if any, which would be prone to scouring effect if placed above 0.3m.
2		**<u>Weave the Grasses through the Poles;</u>** To tap the stream flow, grasses (elephant grass etc.) are woven horizontally through the poles. See the illustration in the left hand. 	A good chunk of grasses is taken, and then is twisted and finally it is woven between the poles. The bundled woven grasses are treaded layer by layer as they are put criss-crossing on upright logs. This kind of compaction is required in order to achieve water tight situation. When the bundle has reached the end, the next bundle should not start at the very end of the last bundle, but rather, it should start at midway in order to minimize gaps.

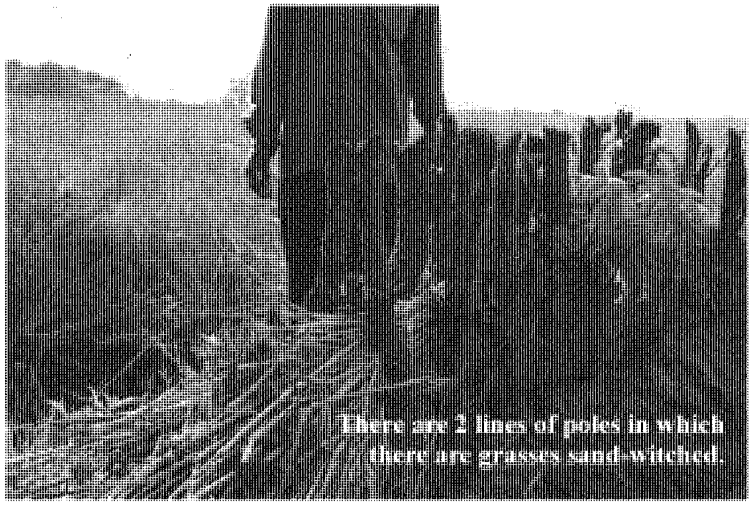
Step	Process	Description	Remarks
3		**<u>Put the clay soil on the Grass Fence;</u>** Put the clay soil on the grass fence. To prevent water leakage from the grass fence and boiling due to sand bed material of the stream, clay soils are put on the grass fence and the bottom of the stream up to certain level. 	It may not be effective to use sandbags as a measure of preventing leakage by boiling/piping on the bottom of the stream. Rather using clay and ordinary soil to seal the gaps in the grass fence and the bottom of stream is effective because the gaps would be clogged with particles of clay and soil. After putting the clay soil on the grass fence and the bottom of stream, soils (stream bed material where appropriate) are thrown to the grass fence.
4		**<u>Completion of Construction;</u>** The weir is completed after following all the steps above.	During operation of the irrigated farming, the diversion weir should be maintained carefully. For instance, if a hole at the weir is found, it should be immediately sealed with clay/ordinary soil. This process will restore the weir its former good shape.

Step	Process	Description
5	**Dismantling the Weir** **Washing the Tools**  **Transporting Materials & Tools to the village** 	**Note; Dismantling the Weir and Set Aside the Main Materials** These types of weirs are constructed as temporary facility for the intake of stream water for irrigation farming in dry season. Therefore, the weir should be dismantled before the start of the rainy season because such kind of structures are constructed across the river/stream and as such, the diversion weir becomes an obstruction for safety flow of floods. Main materials such as logs, bamboos and twigs are then set aside at a suitable place in the village. If properly stored, these materials will be reused for few years to come. **Setting aside the Materials & Tools** 

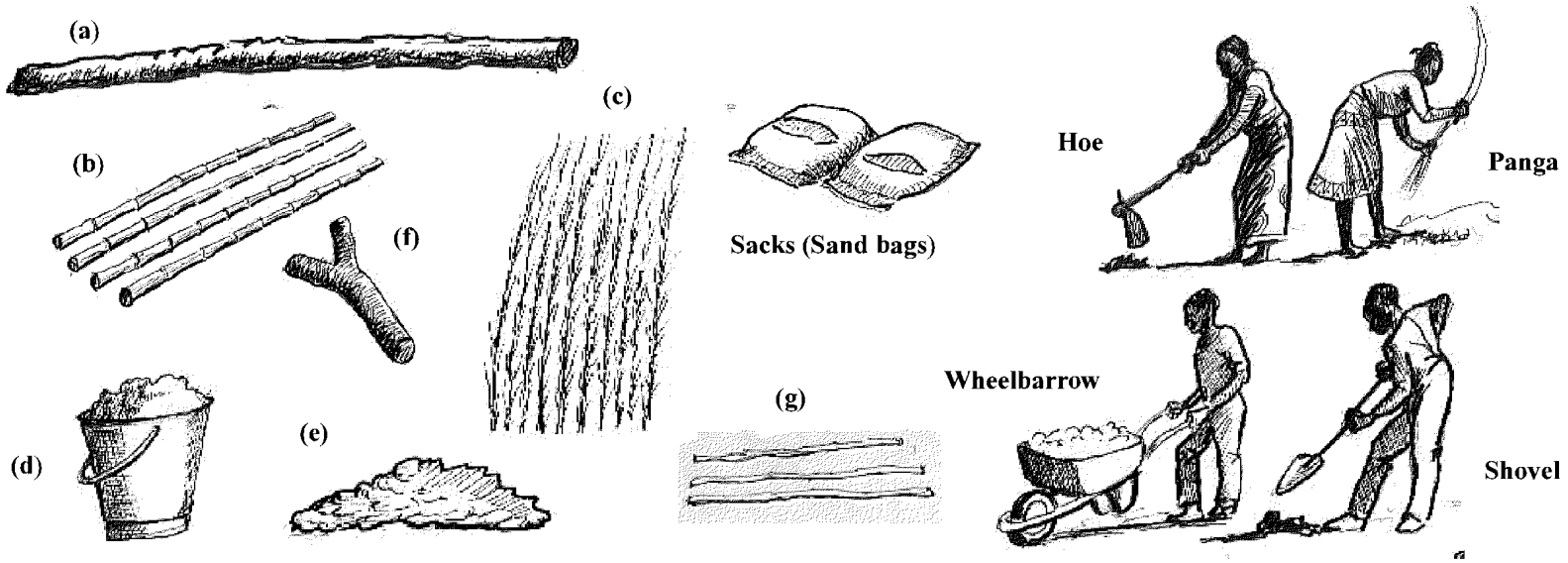
Examples of Single-line Weir (Mbala District (left), Mporokoso District (right), Northern Provicne)

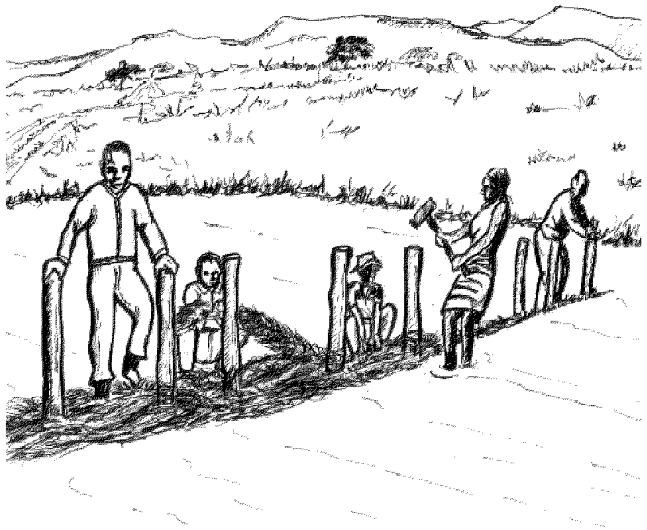
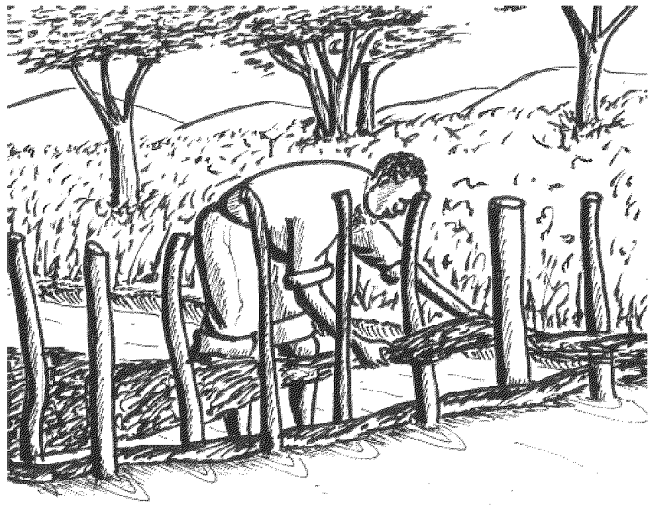


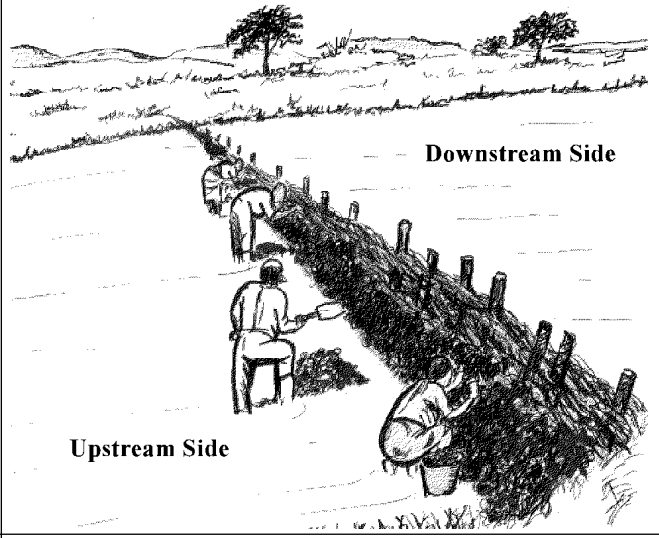
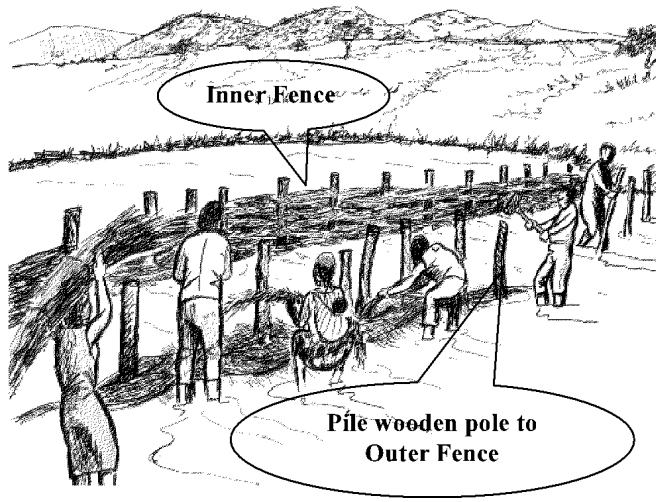


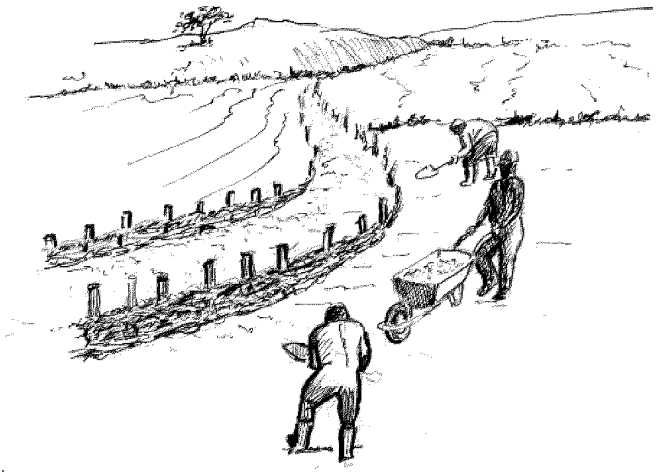
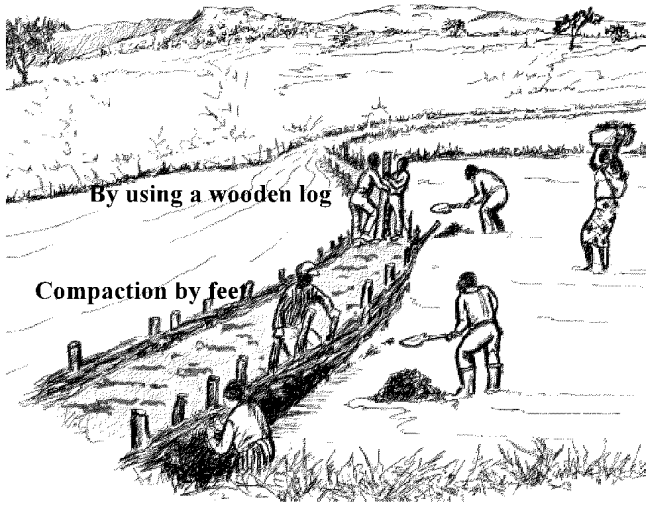
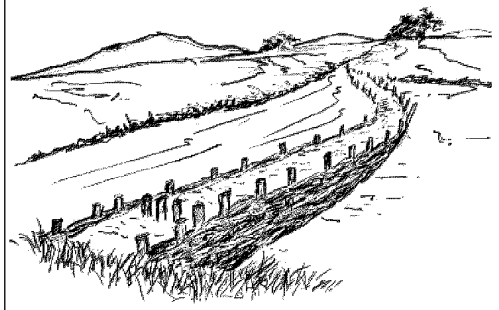


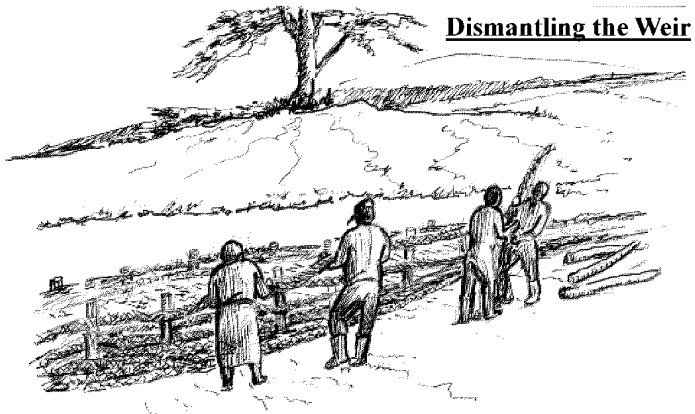
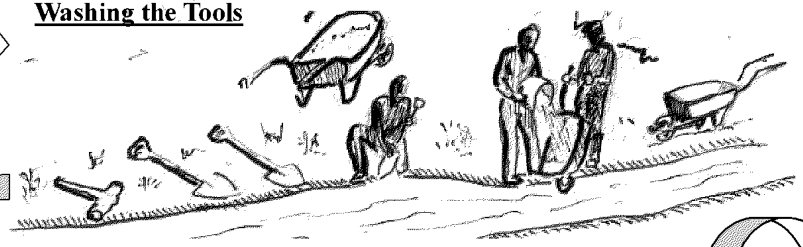
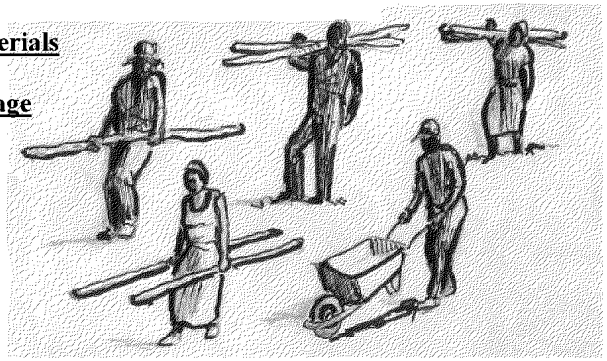
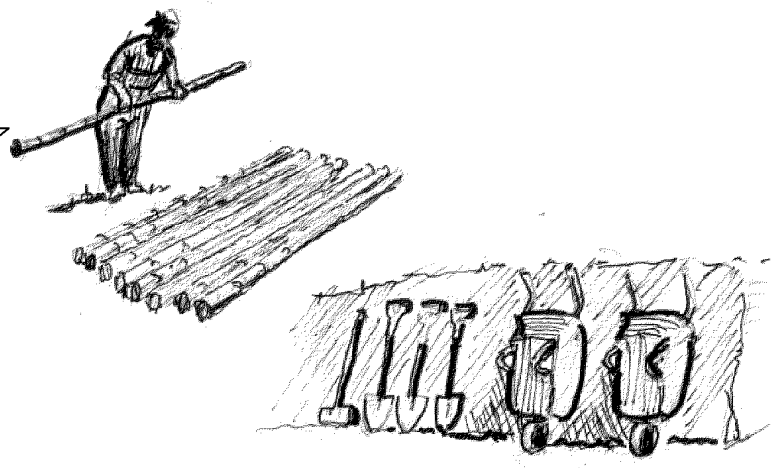
3. Construction of A Temporary Weir: Double-line Wall Type (best suited at wider streams whose foundations are not rock)

Step	Materials to be collected
0	**Collect all the following materials**; (a) Log/Bamboo/Twigs: to make the fence both inner and outer (Quantity: 30-35nos. per 10 meter length of the dam, Refer to Step-1 & 5) (b) Grasses (Elephant grass): to weave into the fences (Quantity: depend on the size of the dam, Refer to Step-2 & 6) (c) Clay soil: to patch in front of inner fence (upstream side) and stuff into the opening of the fences (Quantity: depend on the size of the dam, Refer to Step-4 & 7) (d) Ordinary soil: purpose is same as clay soil **Implements;** Hoe, Shovel, Panga knife, Wheelbarrow, Hammer (Quantity of these implements depends on the number of participants for construction of the dam)
	

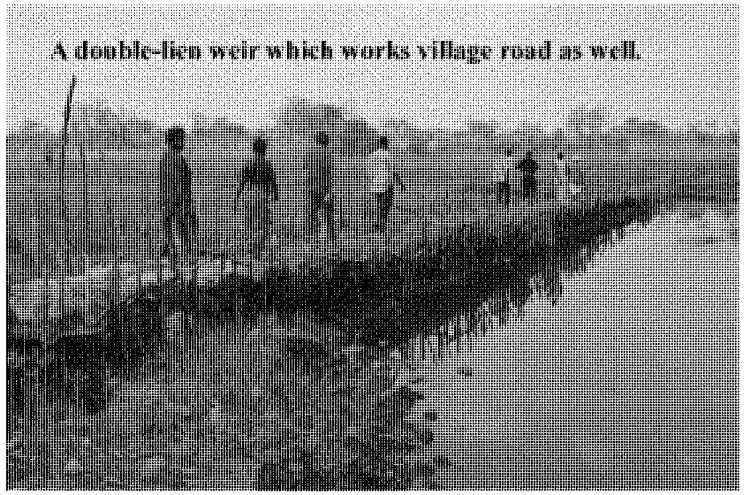
Step	Process	Description	Remarks
1		**<u>Pile Wooden Poles to the Inner Fence (Upstream Side);</u>** To make the inner fence, the wooden poles such as log, bamboo and twigs are piled every 30-50cm interval on the line crossing the stream. When the poles are properly positioned, they are driven into the streambed by a hammer.	In fact, this process of putting inner fence is just same as that of single-line weir construction. As single-line weir may hardly be able to stop water due to the leakage through the weir body, this double-line weir was devised. Therefore, one may say this weir is best suited at a site whose width is relatively wider, so that it is impossible to construct inclined type weir, whose foundation is formed with soil (not rock), so that we can drive poles into the foundation, and where we need to minimize water leakage probably due to a fact that there is little water flowing in the stream.
2		**<u>Weave Grasses into the Inner Fence;</u>** To tap the stream flow, grasses (elephant grass etc.) are woven horizontally into the inner poles following Step-1. Then, the grasses woven are compacted by feet. The moment any grass is weaved between the poles, press it tightly with feet. Continue doing this until a required height of this weir is obtained. The weaving of grass should be done to both fences, so that a space is left in between the parallel fences.	The grasses are bundled and woven horizontally between the wooden poles. A good chunk of grass twisted is taken and finally it is woven between poles. When the bundle has reached the end, the next bundle should not start at the very ending of the last bundle but it should start at midway in order to minimize creating gaps. The bundled grasses which are woven between the poles are treaded layer by layer so as to compact it in order to achieve a water tight situation.

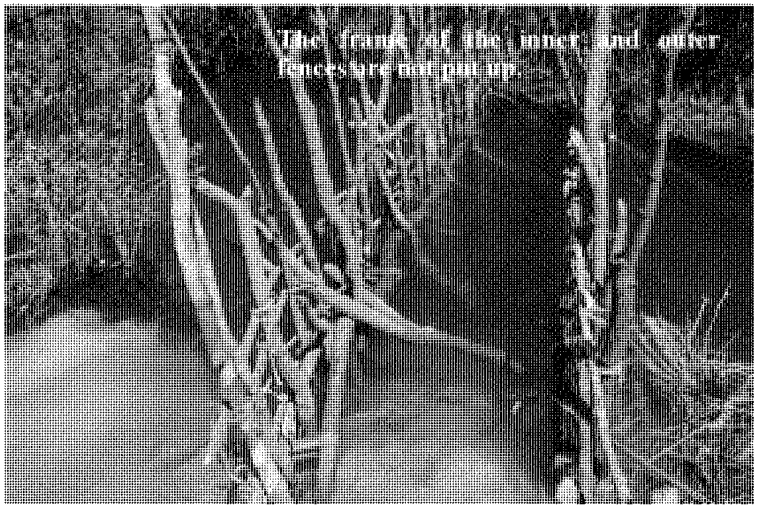
Step	Process	Description	Remarks
3		**<u>Put Clay/Ordinary Soil on the Inner Fence;</u>** Furthermore, clay/ordinary soils are put on the upstream side of inner fence to prevent water from passing through the weir body as leakage. To protect water leakage through the gap of grass fence and boiling due to sand bed material of the stream, the clay soils are put on the upstream side of inner fence and the bottom of stream up to a certain level.	The above Steps-1, 2 and 3 are exactly same as those of single-line weir construction. There may be a difference from the single-line weir; that is the interval of the poles. Since this is to be a double-line weir, a wider interval than that of single-line weir may be accepted, say 50 to even as wide as 70cm interval.
4		**<u>Pile Wooden Poles to the Outer Fence (Downstream Side);</u>** The outer fence is constructed following the Step-3. As first step of making the outer fence, the wooden poles are piled on the line of outer fence such as that of Step-1, preferably 50cm to 1m downstream from the inner fence. Then, being same as Step-2, grasses (elephant grass etc.) are woven horizontally into the outer poles. The grasses should, of course, be compacted by feet/ or using a log in order to achieve a water tight situation.	The poles are hammered into the ground with double lines (namely at outside of inner fence). The whole essence of hammering is to make the structure strong, and to make the poles go beyond sand deposits. The interval between the poles can be 50cm – 70cm, a little wider than that of single-line weir.

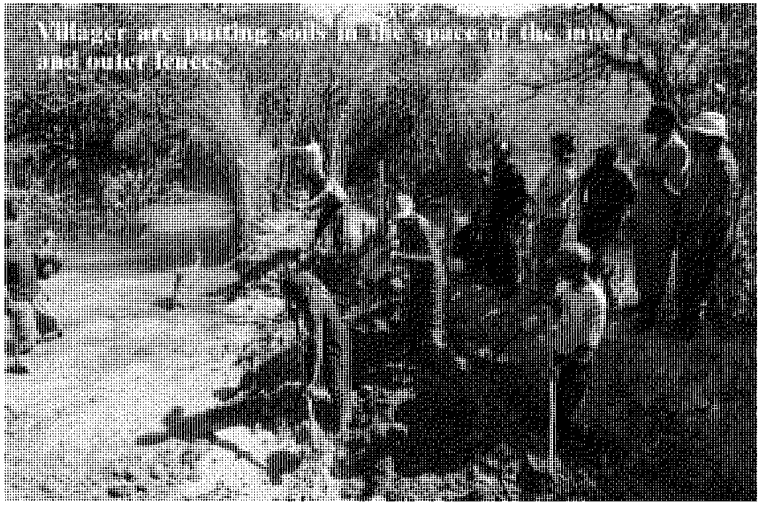
Step	Process	Description	Remarks
5		**<u>Stuff Clay/Ordinary Soils;</u>** Put the soil which exist around the site into the opening between the inner fence and outer fence. To prevent water leakage from the grass fences, clay/ordinary soils are put into the space between the inner fence and outer fence. The clay soil and ordinary soil can be collected around the diversion site.	It should be noted that the wider the space between inner and outer fences, the more soils should be prepared and put into. The wider the space, the less leakage we can expect but the harder the job of putting soils in between becomes.
6		**<u>Compact the Soils;</u>** The clay and soil ordinary soil thrown into the space between the inner and outer fences should be compacted heavily by feet or with a wooden log. After all the process above is followed, the weir is now completed and water starts backing up on the upstream of the weir, then the water starts getting into the diversion canal to flow.	Completion ! 

Step	Process	Description
7	**Dismantling the Weir**  **Washing the Tools**  **Transporting Materials and Tools to the village** 	**Note; Dismantling the Weir and Set Aside the Main Materials** These types of weirs are constructed as temporary facilities for the intake of stream water for irrigation farming in dry season. Therefore, the weir should be dismantled before the start of the rainy season because such kind of structures are constructed across the river/stream and as such, the diversion weir becomes an obstruction for safety flow of floods. Main materials such as logs, bamboos and twigs are then set aside at a suitable place in the village. If properly stored, these materials will be reused for few years to come. **Setting aside the Materials & Tools** 

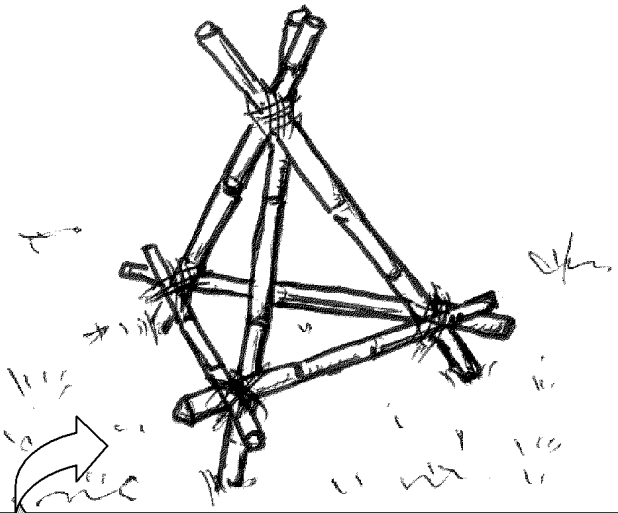
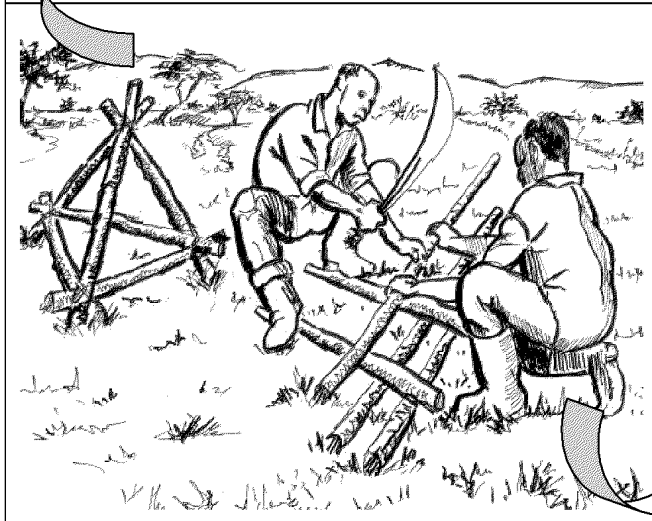
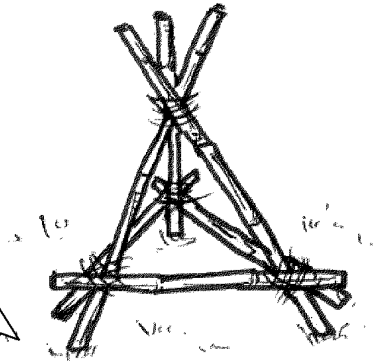
Examples of Double-line Weir (Mansa District (Left), Luapula Provicne, Mungwi District (Right), Northern Province)

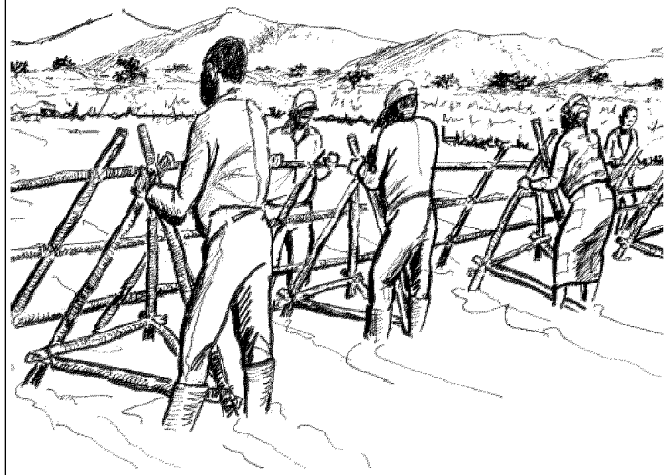




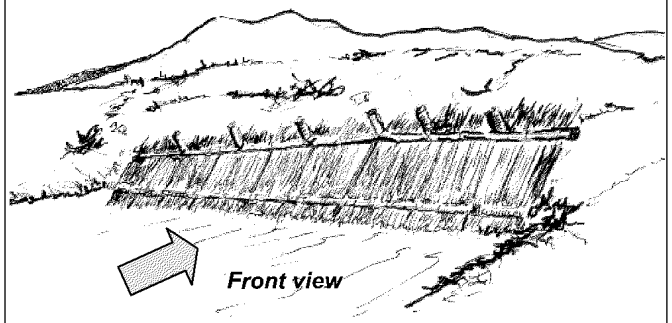
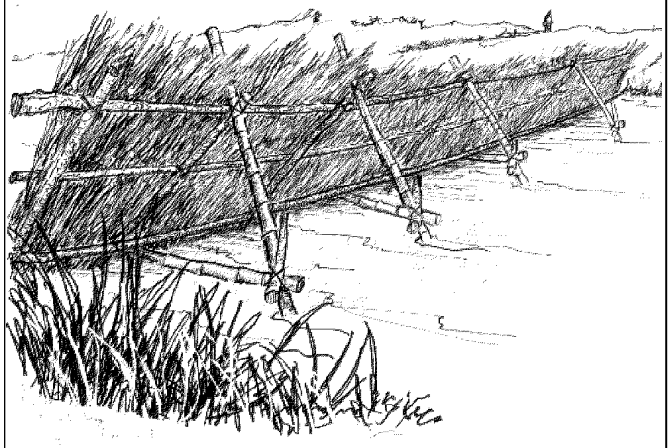


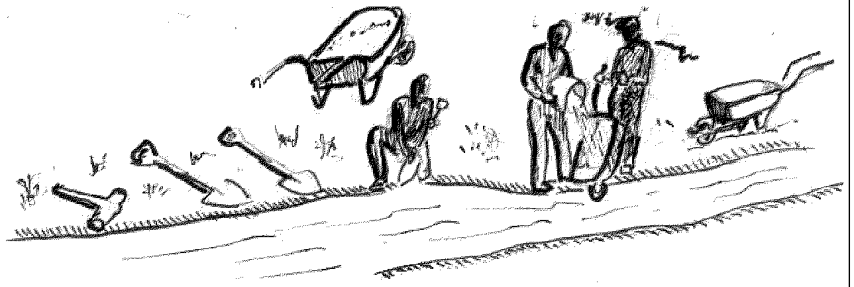
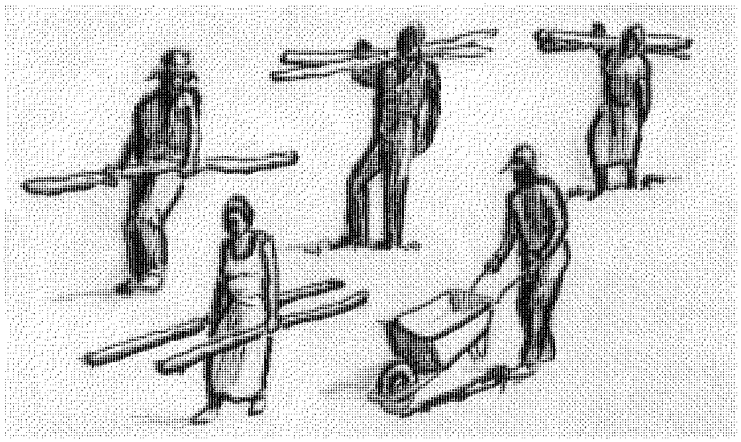
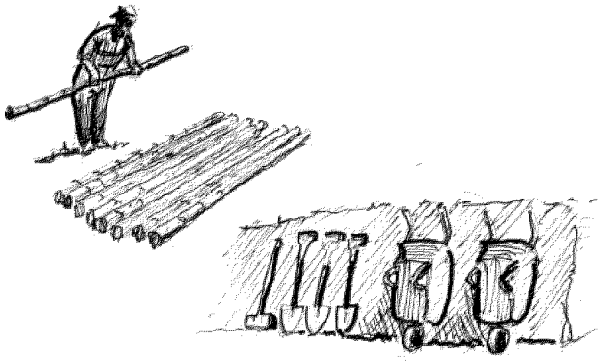
4. Construction of A Temporary Weir: Trigonal Supported Wall Type (can be installed on a rock foundation where wooden logs can't be driven)

Step	Process	Description	Remarks
1		**<u>Assemble the Trigonal Prop (Standing Structure);</u>** To support the brush dam made of grasses/clay soil, the trigonal prop standing structures are assembled as shown in the left illustration.	The trigonal prop can be made of log/bamboo. The size of this structure is adjusted depending on the site condition with reference to the design tapping water level. As an example, each member is cut with a length of 1.3m for 0.5m of tapping water depth design. The diameter can be of the log's/bamboo's one for the trigonal prop; around 7cm - 15cm each. The front of this structure, namely the upstream side, has an inclination to act as support for the fence made of logs, bamboos and grasses with clay soil, and lastly, to stand against the water pressure.
		<u>Refer to the Illustrations</u> Cutting of trigonal prop members and assembling of this structure. 	An angle of inclination of the front face is around 70 - 80 degrees. To tie the members to each other, local materials such as runners/grass/sisal can be used. The horizontal 3 members of the prop, forming the horizontal triangular, should be placed outside of the inclined members, so that it can stand more against water pressure.

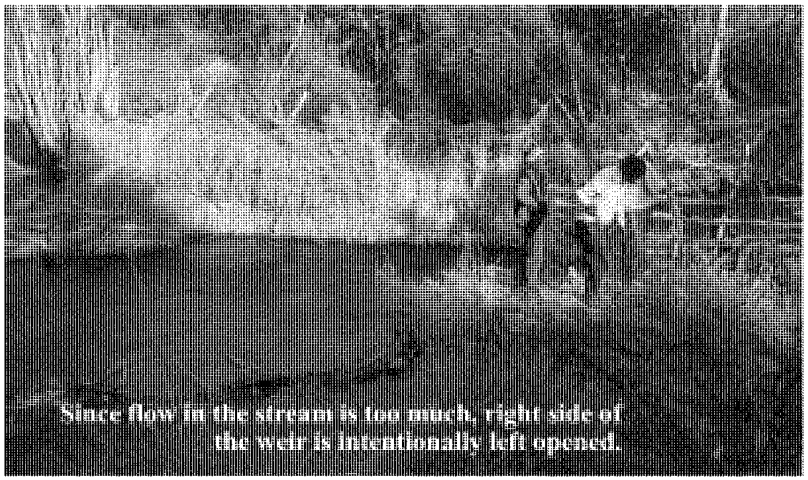
Step	Process	Description	Remarks
2		**<u>Set up the Trigonal Props across the Stream;</u>** The trigonal props are set at the diversion point across the stream. Then, horizontal members are fixed to the trigonal props to keep them in place and in line to each other. At least, 3 horizontal members i.e. upper, middle and lower members should be fixed on the trigonal props. As a result, all of the trigonal props are connected by the horizontal members and will withstand the water pressure as one structure.	The trigonal props are placed at a proper interval in order to prevent this structure from falling down by water pressure. In case of a site in Mungwi district, the width of the stream at the diversion point was about 15m, and 10 trigonal props were set up giving an interval of 1.5m apart. The diameter of fixed horizontal members can be around 3cm - 10cm each. The materials can be wooden poles and bomboos.
3		**<u>Place the Grasses on the Trigonals;</u>** To tap the stream flow, the grasses are placed vertically in front of the trigonal props touching the bed level of the stream.	To reduce the water leakage, it is better to put the grasses very closely. In particular, at the bottom portion of stream, a lot of grasses should be used and should be placed tightly. The horizontal member to be fastened on the top of the grass is the bottom one. Then the second and finally third on top. This helps to keep the grass very tight to the trigonal prop and indeed reinforces the trigonal prop.

Step	Process	Description	Remarks
4		**<u>Tie the Standing Grasses to the Trigonal Structure;</u>** To prevent swelling out of the standing grasses, these grasses should be pressed against the trigonal prop by using horizontal members again tied with runners. Three horizontally parallel members, at the bottom, at the middle and at the top, are finally fastened with the props or otherwise with the horizontal members already set behind the grasses. The grasses are thus sandwiched by those horizontal members set in front and behind.	To press down the grasses on the trigonal prop, another layer of horizontal members are put in front of grasses which are made to run parallel with the first horizontal members already placed at beginning but at a specified interval between each other and these are tightly tied to the first layers of horizontal members. In so doing, grass is tightly sandwiched between horizontal members. The number of layers of horizontal members is dependent on the height of the trigonal weir. In general, 3 lines of horizontal members are placed.
5		**<u>Put the Clay Soil on the Grass Fence;</u>** Clay soil is placed on the grass fence starting from the foundation or streambed level. To prevent water leakage, the clay soil is patched on the grass fence. The clay soil is put not only on the grasses as a part of brush dam but also on the gap between the bottom edge of the grass fence and the natural ground/exposed rock foundation.	Putting of clay soil should be started at the bottom, and much attention should be put at this stage. This is because this area is very critical in reducing water leakage and thus where the water pressure is the highest. A lot of clay soil should be placed at the bottom in order to make it water tight as much as possible to prevent leakage.

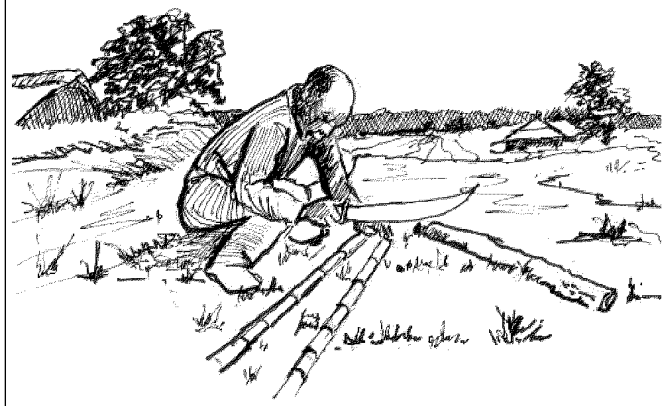
Step	Process	Description	Remarks
6	 *Diversion Weir in a Wide Stream: Rock Foundation*	**<u>Completion of Construction;</u>** <u>The front / Upstream of the Weir</u> Water finally backs up at the upstream of the weir and the duration of backing up depends on the stream width. The weir is finally completed. 	With this trigonal supported weir, water depth stored could reach over 1.0 m or even more than 1.5 m. However, the higher the water level is, the riskier it is and therefore it may fall down. Therefore, it is not recommended to store water over 1.0m.
		<u>The back / Downstream of the Weir</u> 	Check the inclination of the weir. The bamboos supporting the trigonal prop, which is at an inclined angle, is clearly seen / shown in the pictures with its horizontal support. The water level in the downstream is lower than the upper stream of the weir. The trigonal props also help resisting the water pressure which is greater at the bottom, hence the unique design the trigonal prop.

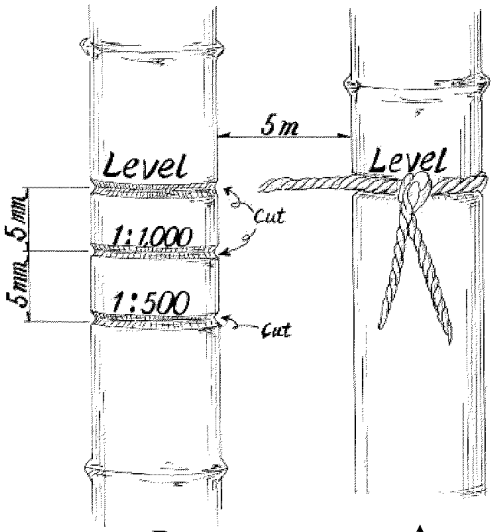
Step	Process	Description
7	**Dismantling the Weir** **Washing the Tools**  **Transporting Materials & Tools to the village** 	**Note; Maintaining the Weir** During operation of the irrigated farming, the diversion weir should be maintained carefully. For instance, if a hole is found on the weir, it should be immediately sealed with clay/ordinary soil. This process will restore the weir its original good shape. **Note; Dismantling the Weir and Set Aside the Main Materials** These types of weirs are constructed as temporary facility for the intake of stream water for irrigation farming in dry season. Therefore, the weir should be dismantled before the start of the rainy season because such kind of structures are constructed across the river/stream and as such, the diversion weir becomes an obstruction for safety flow of floods. Main materials such as logs, bamboos and twigs are then set aside at a suitable place in the village. If properly stored, these materials will be reused for few years to come. **Setting Aside the Materials & Tools** 

Examples of Trigonal Supprted Wall Type (Mungwi and Mpila Districts, Northern Province)

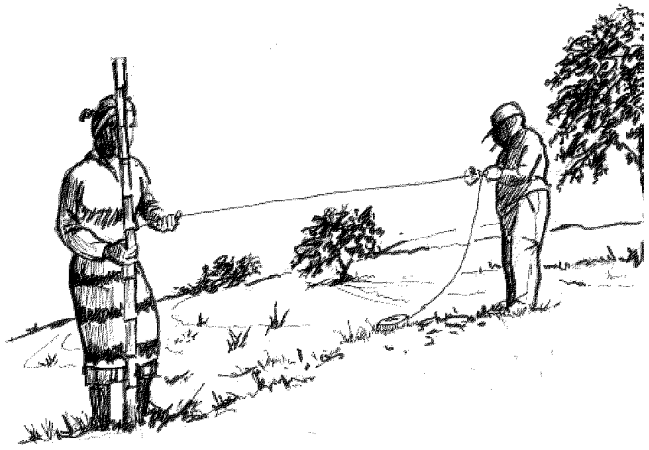
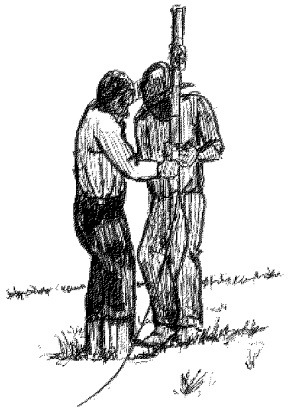
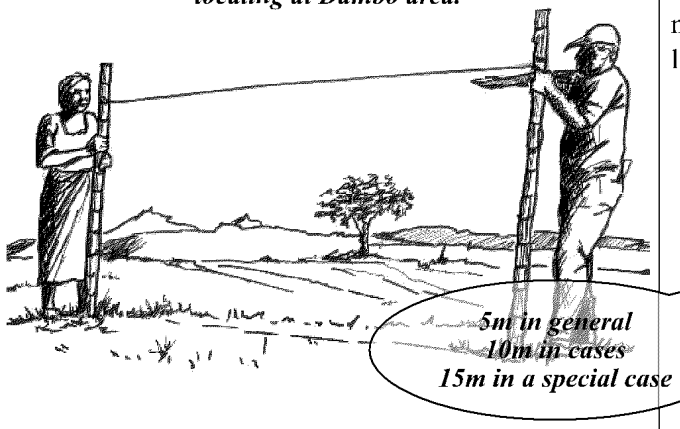
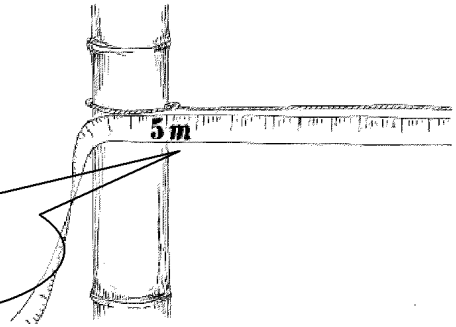


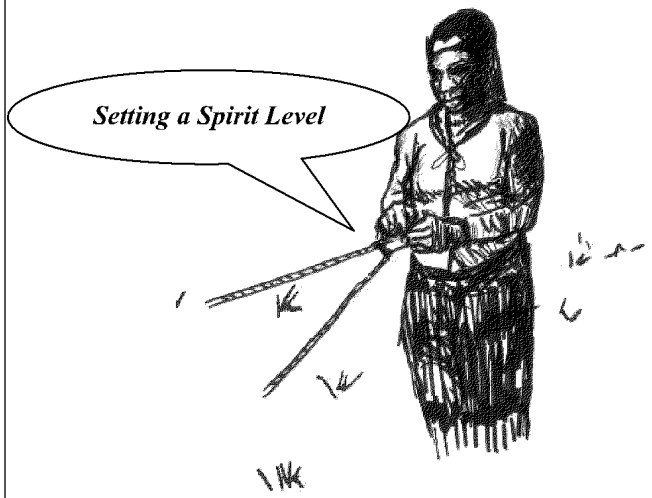
5. Canal Alignment with Sprit Line-level (Section 1; Assemble Line-level)

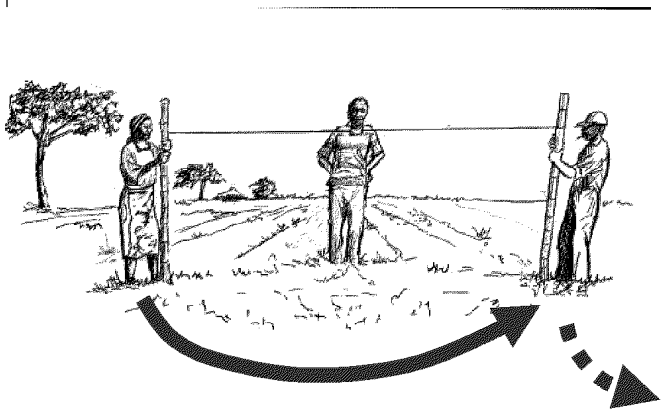
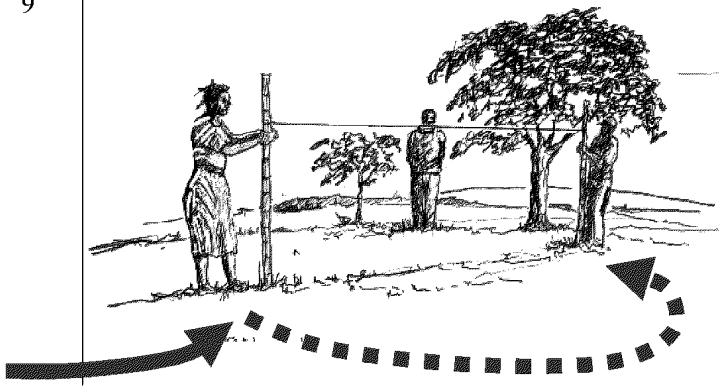
Step	Process	Description	Remarks
1		**<u>Adjust the Poles;</u>** Two (2) poles should be prepared and are cut in the same length. 	Local materials such as bamboo/wooden poles are applicable. The lengths of poles should be adjusted to the height of pole holders. Usually, the poles are about 1.7m to 1.8m in height. The poles should have a sizable diameter so that they are easy to hold. Bigger poles with bigger diameters would be difficult to handle.
2		**<u>Make Groove on the poles (to know gradient on field);</u>** To tie and fix a string, make circular groove around the poles at the same height of both poles—around 1.0-1.3 m from the bottom.	The position of the groove should be set in accordance to the height of the reader of the spirit level. Usually, the height of the groove is from 1.0m to 1.3m from the bottom of the poles. When measuring the level point on field, the grooves should be marked with same height of both poles. However, when measuring a particular slope, grooves should be set at different heights. The table on the next page shows an example of positioning the groove on each pole according to a required slope (same as canal longitudinal gradient).

Step	Process	Description	Remarks
3		**<u>Put Grooves at Different Heights on One of the Poles:</u>** Take one of the poles and make grooves on the pole as shown in the left illustration. The position of the groove is 5mm lower than the first one (top one), and another 5 mm from the first one. The pole at the right side has a groove fixed at, for example, 1.3m from the bottom of the pole as an example (see the groove on the Pole A). On the other hand, the pole standing at the left hand side has 3 grooves (see the grooves on the Pole B). These grooves indicate the level line, 5mm lower than the level line and 10mm lower than the level line.	In conventional way of using a sprit line level, the 2 grooves should be put on the same height in order to know the same elevation points at the 2 poles. However, to align a canal with a designed gradient, we need to make a difference of the elevation in between the grooves of the 2 poles. As an example, 5 mm difference over a distance of 5m gives 1/1,000 (5mm/ 5,000mm) gradient, and 10 mm difference over the same 5m distance gives 1/500 (10mm/5,000mm) gradient. If the 2 poles are placed over a distance of 10m, 10mm difference gives 1/1,000 (10mm/ 10,000mm) gradient and 20mm difference gives 1/500 (20mm/ 10,000 mm) gradient.
			The table shown on the left gives an example for the position of the grooves (tying position of the string for the 2 poles) to set the designed slope of canal on the site. On a gentle topography like *Dambo* areas, 1/1,000 is recommended while on a sloped topography, 1/500 slope is recommended.

Design gradient of canal	Elevation difference of 2 grooves	Distance between the 2 poles	The position of grooves from the bottom	
			Stick-(A)	Stick-(B)
1/1,000	5.0 mm	5 m	1.3 m	1.295 m
1/500	10.0 mm	5 m	1.3 m	1.290 m
1/1,000	10.0 mm	10 m	1.3 m	1.290 m
1/500	20.0 mm	10 m	1.3 m	1.280 m

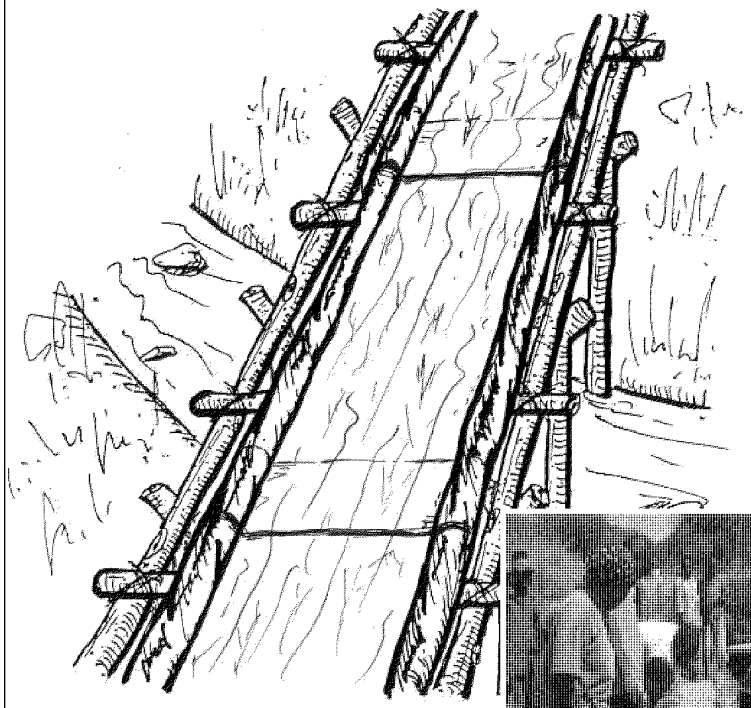
Step	Process	Description	Remarks
4		**<u>Fix the String;</u>** Tie the string on a grove marked on the above steps. 	
5	***The distance should be 5m in general, but may be extended to 10m in the site locating at Dambo area.***  ***5m in general 10m in cases 15m in a special case***	**<u>Testing the line-level;</u>** The length of the string, same as the distance of the 2 poles, should be 5m in most cases but in some cases it can be as long as 10m.  ***5m***	The length of string depends on the site condition. Usually, 5m length of string is ideal as it is easy to handle. However, if the topography is too gentle and difficult to find an appropriate point within the 5m distance, extend the string up to 10m. Elevation difference of 10-20 mm could be found within the 10m distance. In case you cannot still find out appropriate point within the 10m distance, you might extend the distance of the 2 poles up to 15m as a special case. In this case, 15mm elevation gap can give 1/1,000 gradient (15/15,000) and 30mm elevation gap can give 1/500 gradient (30/15,000).

Step	Process	Description	Remarks
6		**<u>Set a Spirit Level (completion of assembling the line-level):</u>** After the required span between the poles is set, set the spirit level on the string. 	The position where the spirit level is fixed should be the center of the string, e.g. 2.5m point with 5m of string, 5.0m point with 10m of string.
7		**<u>Starting the Canal Alignment with Sprit Line Level:</u>** Line-level can be used to know a sloping point for the design longitudinal slope of the canal. To survey that, at least three persons are needed: two for pole holders and one to read the level.	A slope of 1/500 on a sloped (inclined) land is recommended while 1/1,000 slope may be applied on a flat land e.g. *dambo* areas. One may think 1/1,000 slope is too gentle for water to flow. However, this slope is quite enough to let the water flow in the canal by gravity. As most topography in Zambia is very gentle, steep canal slope with more than 1/500 is not recommend. On the other hand, gentler gradient than 1/1,000 is not recommended either since spirit line level may not accompany such accuracy.

Step	Process	Description	Remarks
8		**<u>Surveying Sloping Point on the Field;</u>** The pole holders should stand at an interval of 5 meters or 10 meters according to the length of the string put over the poles. At this time, the pole holder whose string is tied at a lower position than that of the other pole should stand at a higher position e.g. at the starting point of the canal (He/she stands on the left side in the illustration). The other pole holder (the person on the right) will move to the point where the bubble in the spirit level comes to the center. The level reader checks whether the bubble in the spirit level is at the center or not.	The tied point on the right pole is, as an example, higher by 5 mm than the tied point on the left pole in the illustration. With this situation, when the bubble in the sprit level comes to the center, it automatically means that the ground at the right pole is 5 mm lower than that of left pole. If the distance of the 2 poles is 5m, it gives 1/1,000 gradient (5mm/ 5,000 mm) to the ground over the 2 points).
9	 This placing may be called off-set leveling since the evaluation gap between the grooves is off-set by the elevation difference of the ground where 2 poles are placed.	**<u>Do progressing Placing of the Poles:</u>** After a sloping point is set, the pole holder who stands at higher point (left person in the illustration) should move the point to where the other one was (right person in the illustration). The points where the pole holders stand act as bench marks where the pegs are now driven. After this, repeat the same procedure until the required distance of canal is achieved. Upon completion of the line-leveling over the designed distance of the canal, re-align some pegs to get a smoother canal alignment (avoid zigzag alignment).	This method is completely different from conventional pole placing. Conventional placing requires us to place the 2 poles alternately in order to identify a counter level, while this canal alignment necessitates us to place the 2 poles progressively. By placing the 2 poles progressively, designed elevation difference, corresponding to the canal longitudinal slope, over the 2 points is secured since the tying points of the string on the 2 poles are different in elevation.

6. Canal Design and Construction

Canal Ancillaries

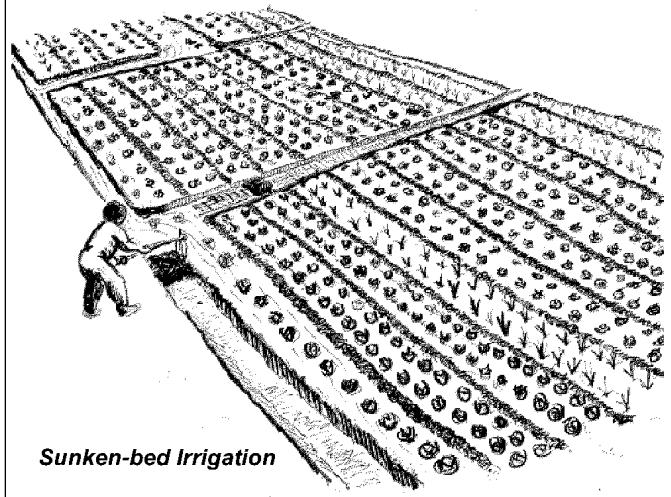
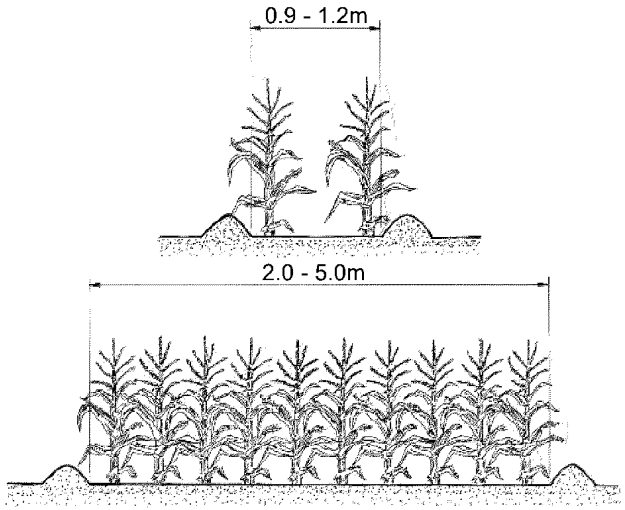


A Canal Bridge crossing a gully:
On the frame assembled with wooden poles and supported by twigs from the ground, long tall grasses are placed on and a bunch of grasses about 20 cm in diameter is placed on the both edges, and thereon plastic sheet is placed.

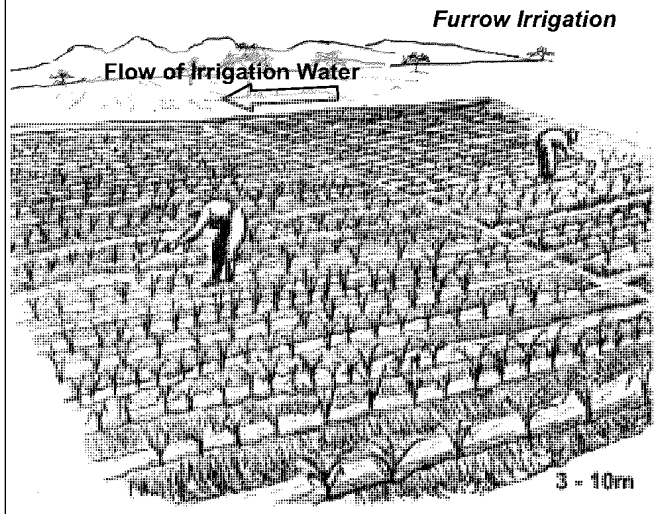
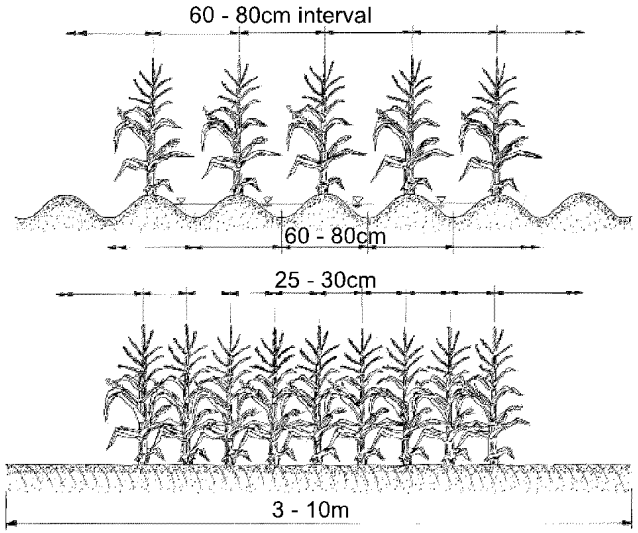
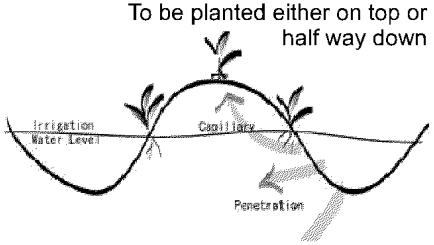
On-farm ditch covered with stone pitching:
Where farm land is located on a sloped area, stone pitching can be applied on the ditch in order to prevent the soil from being eroded.

If stone is not available in and around the site, even banana sheath can be used as a temporal material for ditch lining in order to prevent soils from being eroded.

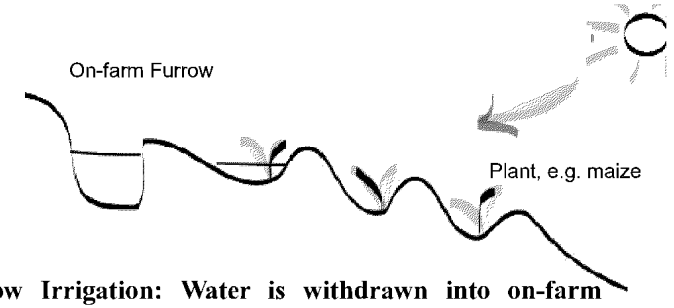
7. On-farm Irrigation Method (Section 1; Sunken-bed Irrigation)

Step	Process	Description	Remarks
1	 *Sunken-bed Irrigation*	**Making the Sunken Bed;** This sunken-bed on-farm irrigation system is applied to a very flat area, and not to steep topography. To do this on-farm irrigation method, make a sunken bed, which is a leveled area in the field, surrounded by earth bands. The leveled area is flooded during the on-farm irrigation. Sunken-bed irrigation is suitable for many crops.	In sunken beds, the crops grow on the flat surface, which are surrounded by small earth embankment and are kept wet for a long time when the bed is irrigated. The advantages are; 1) the amount of water can be given with a minimum amount of labor if beds are well leveled, 2) water losses can be kept low by minimum run-off, and 3) beds last for a long time once they are constructed.
2		Refer to the Illustrations Sunken-bed irrigation needs a good water supply to fill the basin quickly. This in turn requires accurate land leveling with a good earth embankment surrounding the bed. Also it is required that the intake at the bed should be clogged when the water reaches around 3/4 of the length of the bed, after which water is to reach up to the end by gravity in the bed.	The width and length of the sunken bed is normally 0.9 - 1.2m and 2.0 - 5.0m respectively but depends on the type of crops and soil. If the soil is sandy, it is recommended to shorten the length, say to 3 m or even to 2 m length.

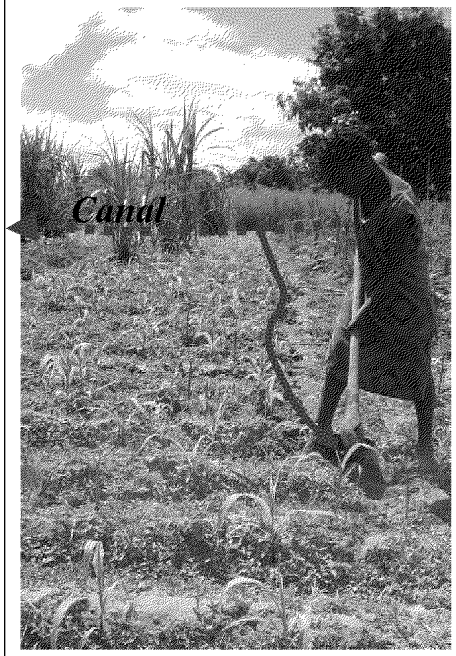
On-farm Irrigation Method (Section 2; Furrow Irrigation)

Step	Process	Description	Remarks
1		**<u>Making the ridges and furrows;</u>** This furrow on-farm irrigation system is applied to a relatively steep topography, and not to very flat area. To practice this on-farm irrigation, make ridges and furrows, just same as the one for rain-fed agriculture. Note that the interval of ridges, same as that of furrows, should not be too wide, say not over 100 cm in any case. Intervals of over 100 cm can be seen in rain-fed agriculture, however with these wide intervals, irrigation water can hardly wet the crops planted on the ridges.	Under furrow irrigation, water is taken to the plant through long and narrow on-farm channels (on-farm furrows) formed in the soil at regular intervals, between the crop rows (ridges). The length of the furrow is normally 3 - 10 m but depends on the type of soil and the land slope. If the topography is very uniform, the length of furrows/ridges can be extended up to 10m or otherwise better to limit within 5m in most cases.
2		<u>Refer to the Illustrations</u> Water is gradually absorbed into the bottom and sides of the long on-farm channel (on-farm furrow) wetting the soil. Crops are usually grown on top of or half way down the ridges between furrows. 	It is important to use the right shape of furrow, furrow spacing and length. Good water management is of course very much important for the method to work well. The interval of ridge is usually 60 – 80 cm, equivalent to the one applied under rain-fed agriculture or somewhat narrower than that. Ridge height, equally to furrow depth, should be around 20 – 25 cm in order for capillary to lift the water toward ridge. Cops are planted at intervals of 25 –30 cm on top of or half way down the ridges, which is also equivalent to the practice of rain-fed agriculture.

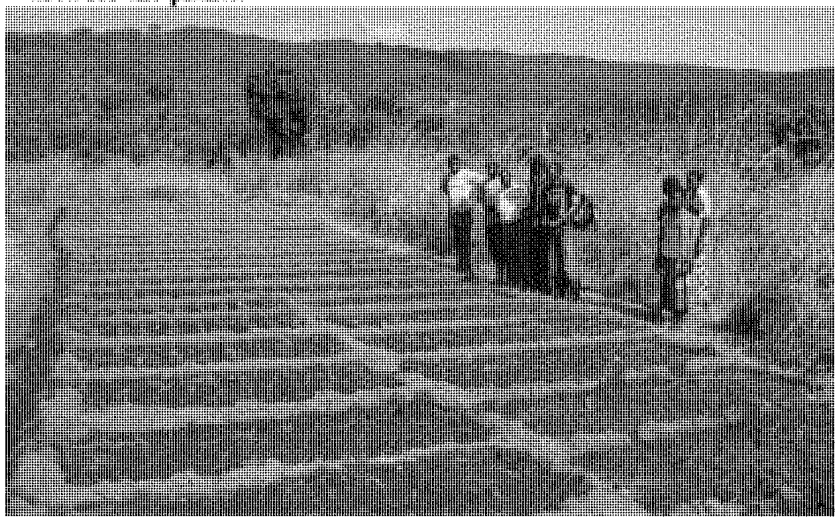
Examples of On-farm Irrigation Method (Furrow rrigation and Sunken-bed Irrigation)



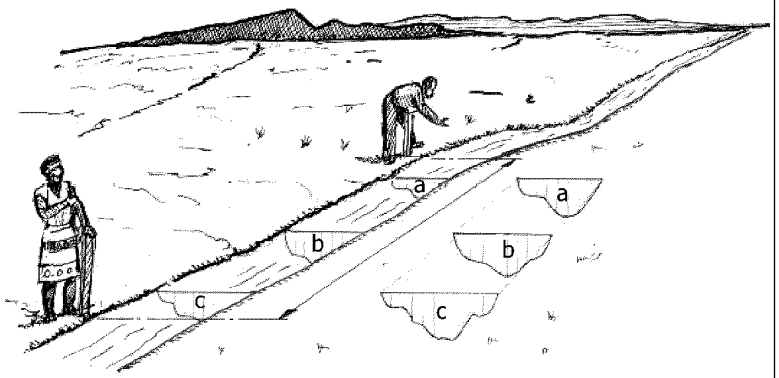
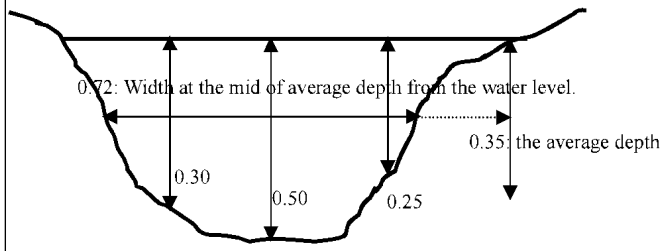
Furrow Irrigation: Water is withdrawn into on-farm furrow, and then wets the soils by capillary.



Sunken-bed irrigation: Sunken-bed is a leveled area surrounded by earthen band. Water is led to this bed and wets whole the bed area for the plants.

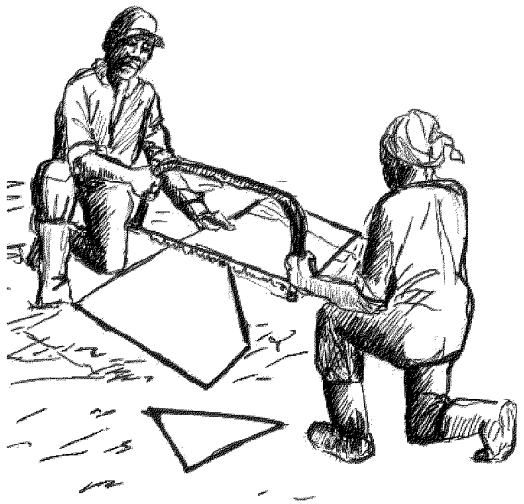
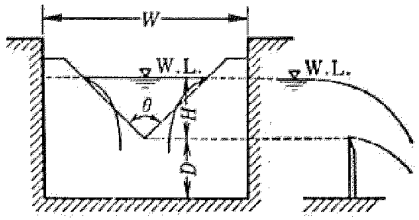


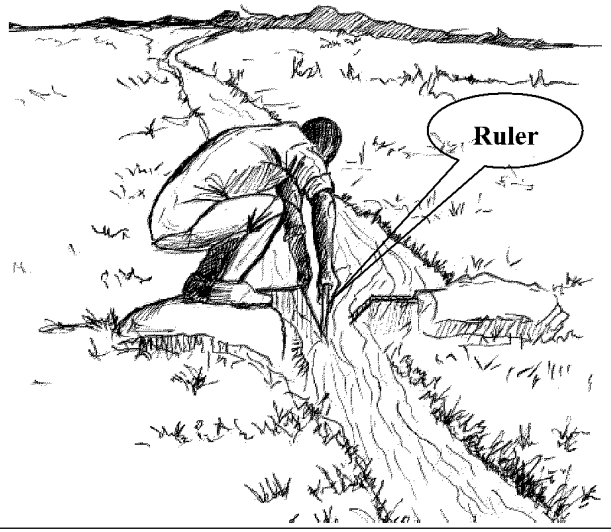
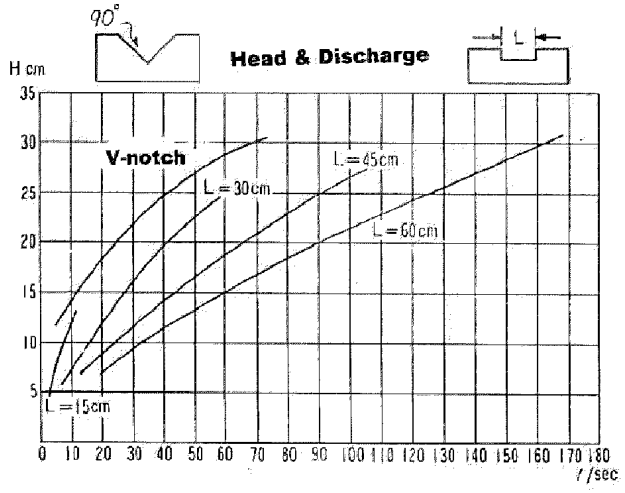
8. Discharge measurement (Section 1; Float Method)

<table>
<tr><th>Step</th><th>Process</th><th>Description</th><th>Remarks</th></tr>
<tr><td>1</td><td> 
</td><td><u>Measurement of the Water Area;</u>
The float method is available to know a rough estimate of the stream flow. The amount of flow (Q) can be estimated by measuring the size of the stream (A=water area) and the speed (V=velocity) of the water (Q=A*V).</td><td>The water area of the stream (width multiplied by depth) has to be measured. It is better to select a clean and straight section on the stream, at least 5 – 10m long. Measure the depth at one cross-section for at least 3 points (e.g. at 1/4, 1/2, and 3/4 of total width as in the bottom illustration) and calculate the average depth. Then, multiply the average depth into average width of the section, which is the width at the mid point of the average depth from the water level. After the water area for each cross-section is calculated, the representative water area (A) is estimated by averaging all the cross-sectional areas.</td></tr>
<tr><td>2</td><td>How to estimate a cross sectional area:
 

<table>
<tr><th colspan="2">Depth (m)</th><th>Width, m</th><th>Area, m^3</th></tr>
<tr><td>Depth 1 (1/4)</td><td>0.30</td><td rowspan="4">0.72</td><td rowspan="4">0.252 m^3
(0.35x0.72)</td></tr>
<tr><td>Depth 2 (1/2)</td><td>0.50</td></tr>
<tr><td>Depth 3 (3.4)</td><td>0.25</td></tr>
<tr><td>Average</td><td>0.35</td></tr>
</table></td><td><u>Measurement of the velocity;</u>
A float (e.g. a piece of dry wood) is thrown into the water to measure the velocity. Measure the time (in second) taken by the float to move between the upstream cross-section point (section-a) to the downstream one (section-c). Repeat this measurement at least three times, and calculate the average velocity. Velocity is calculated as follows:
Velocity=Length (m) of the 2 points (e.g. section-a to section-c in the illustration) / time (in second)</td><td>The measured velocity at the surface is larger than the velocity along the bottom and sides. Therefore, the measured velocity at the surface needs to be corrected as follows:
-When the water depth<30cm,
Velocity=average velocity times 0.70
-When the water depth>30cm,
Velocity=average velocity times 0.85
Finally, multiply the average water area by the corrected average velocity. This is the amount of flow (Q=A*V) in cum per second. When multiplied by 1,000, it is now the flow in litter per second.</td></tr>
</table>

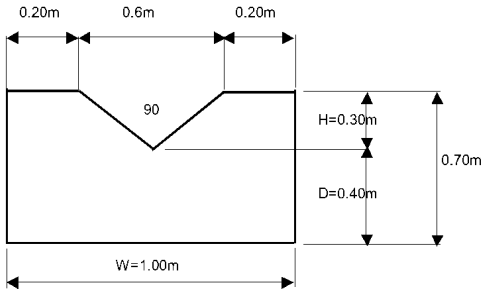
Discharge Measurement (Section 2; V-notch Method)

Step	Process	Description	Remarks
1		**<u>Making a V-notch;</u>** Generally, the v-notch is made of wooden board at an angle of 90 degrees. 	If the amount of stream flow is small such as up to 100 lit/sec, v-notch is available to measure the discharge. The application of v-notch is as following (refer to the figure show in the left): • 0.5m<=W<=1.2m • 0.1m<=D<=0.75m • 0.07m<=H<=0.26m • H<=W/3
2		**<u>Set the V-notch in the Stream;</u>** The v-notch is set up at suitable site near the place where it is planned to construct the diversion weir.	The v-notch must stand perpendicularly to the stream flow. To stabilize the v-notch, sand bags can be used.

Step	Process	Description	Remarks
3		**Measure the Depth of Nappe;** After setting of the v-notch, the stream flow starts overflowing through the v-notch. The v-notch will be left as it is. When the nappe has become stable, the depth of the nappe has to be measured. The depth here means the distance between the deepest point of the V-notch and the water level right above the deepest point.	To measure the depth of the nappe, a ruler should be prepared. The ruler should be placed perpendicular to the flow exactly, or error in the measurement will take place.
4		**Read the Graph or use Tables;** The amount of stream flow can be known by the graph shown on the left column, or refer to the tables on the following table.	After measurement of the depth of nappe, the depth is checked against the graph to know the volume of flow. The graph shows the relationship between the depth of nappe and discharge. Or otherwise refer to the table on the following page. An exercise in case of V-notch; The depth of nappe: 25cm The amount of flow: 40 lit/sec

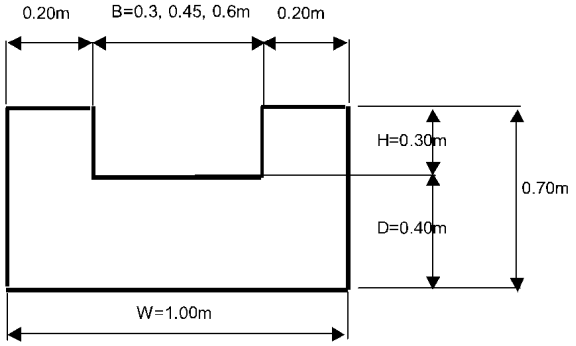
Step	Table of Discharge against Ovewflow Depth
4	**In case of V-notch:**

Over flow depth on V-notch	Discharge	
h (m)	Q (m^3/min)	Q (lit/sec)
0.07	0.11	1.83
0.10	0.26	4.41
0.12	0.42	6.92
0.14	0.61	10.14
0.16	0.85	14.14
0.18	1.14	18.96
0.20	1.48	24.67
0.22	1.88	31.31
0.24	2.34	38.95
0.26	2.86	47.63



Step	
4	**In case of rectangular notch:**

Over flow depth on R-notch h (m)	Discharge		
	B=30cm	B=45cm	B=60cm
	Q (lit/sec)	Q (lit/sec)	Q (lit/sec)
0.10	16.59	25.17	34.00
0.12	21.88	32.93	44.54
0.14	27.72	41.36	56.02
0.16	34.08	50.43	68.37
0.18	40.96	60.09	81.56
0.20	48.35	70.32	95.54
0.22	56.23	81.11	110.29
0.24	64.62	92.43	125.80
0.26	73.51	104.27	142.03
0.28	82.90	116.62	158.98



Technical Cooperation Project for Community-Based Smallholder Irrigation (T-COBSI)

IMPLEMENTATION MANUAL FOR SMALLHOLDER IRRIGATION DEVELOPMENT (PERMANENT-WEIR SCHEME)

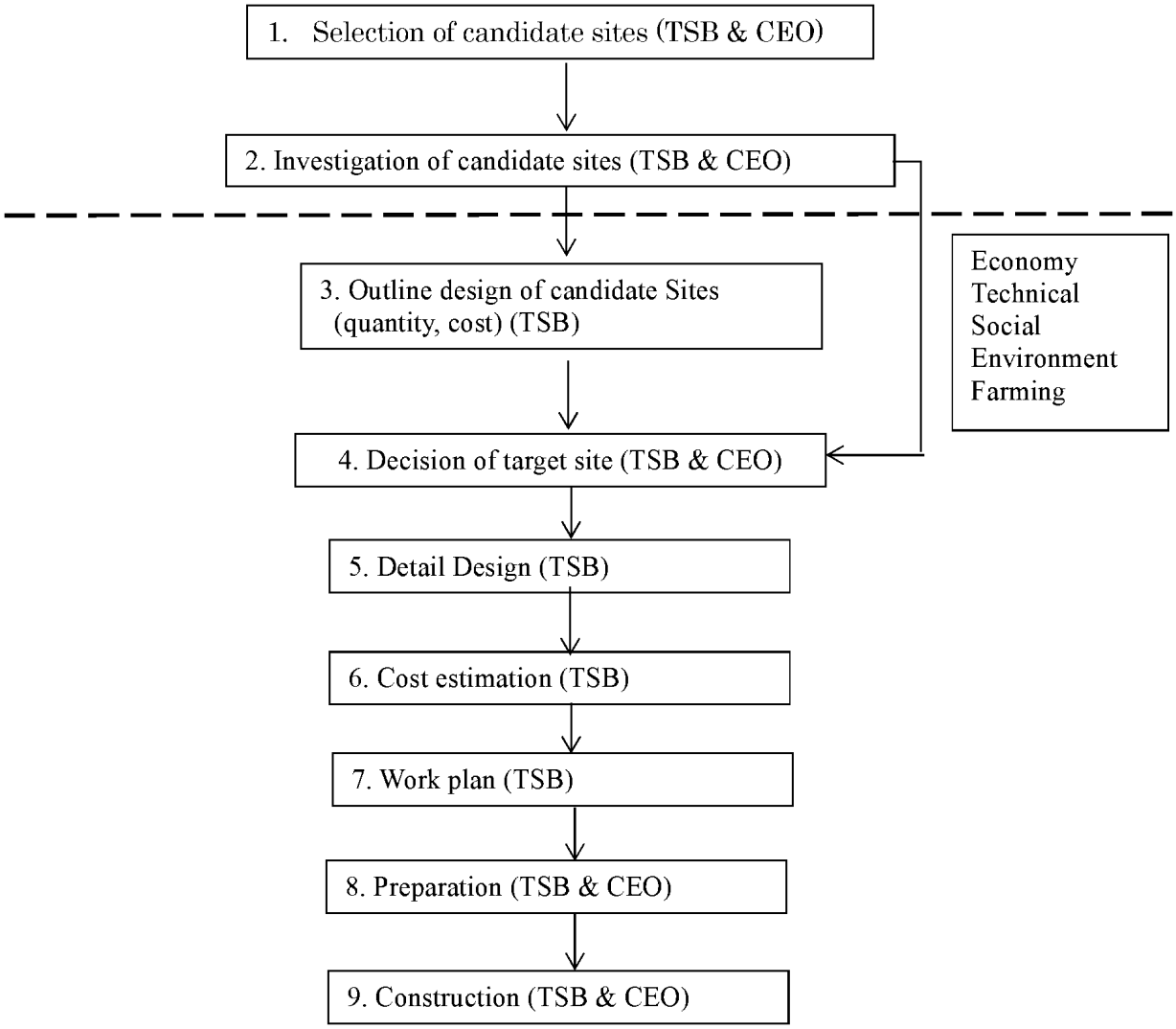
April 2016

Japan International Cooperation Agency (JICA)

Ministry of Agriculture and Livestock (MAL)

Module 5. Implementation of a Permanent Weir Project

5.1 Implementation Procedure



5.2 Selection of Candidate Sites

Candidate sites are selected considering existing information; natural conditions, social conditions, environmental conditions and O&M such as, (1) slope of riverbank, (2) streamline, (3) terrain, (4) riverbed material, (5) potential area, (6) number of household, (7) farmers organization, (8) available water source, (9) water use of upstream and downstream etc.

(1) Preparation of a topographical map

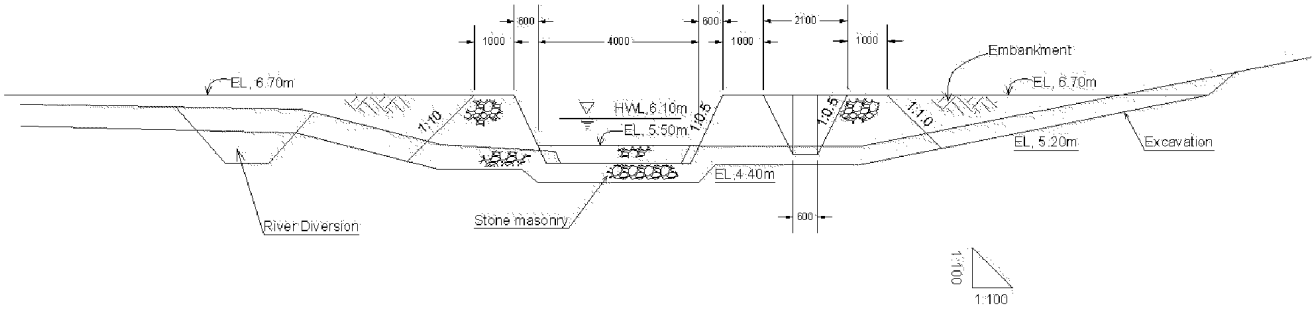
If any topographical maps with sufficient precision for the plan are already available from the basic national land survey, the cadastral survey, and the relevant land improvement projects, they can be used. If they have not been prepared yet, it is desirable to prepare them at the initial stage of the

investigation. Generally, the topographical map shall be prepared to cover the following area: the beneficial area, its peripheral areas, and areas necessary for planning for irrigation system. GPS and Google Erath can be utilized to get topographical information.

(2) Slope of riverbank

Slope of riverbank should not be very gentle. If it is gentle, the length of weir will be very long. In many case, the height of weir is about 1.5 ~ 2.0m from river water level. If the slope is 10%, the length of weir should be more than 30 ~ 40m. Water table also should be checked observing the surface of slope.

Gentle slope



Steep slope

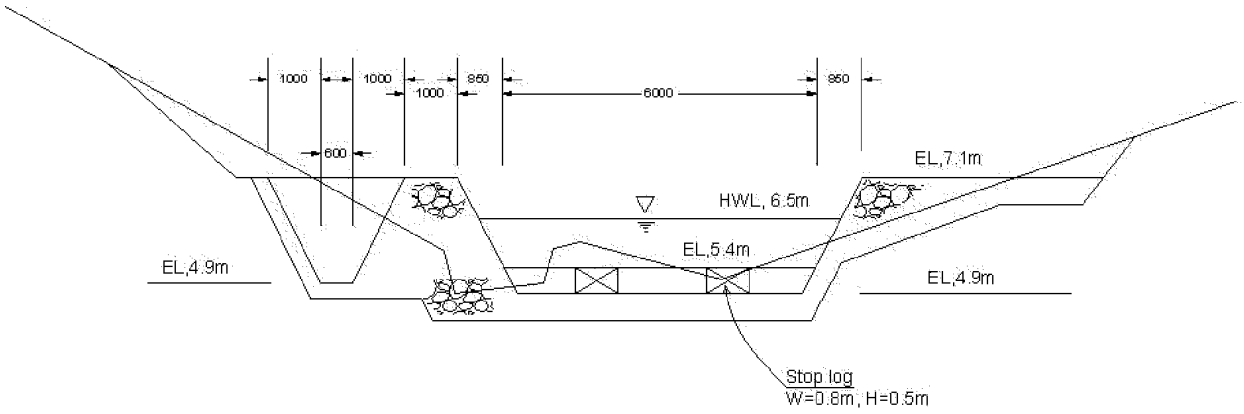


Figure 5-1 Slope of Riverbank and Weir
Source: T-COBSI Project Team

(3) Streamline

Streamline should be stable. It is also desirable to be straight. Streamline in a flat low land tends to be unstable and winding.

(4) Terrain

Dumbo area is excluded in the candidate sites. Generally, temporary weir in dambo area is located in wide flat low land.

(5) River bed material

Rocky foundation does not need apron. Sandy foundation requires long length of apron. Sandy

foundation has a difficulty of de-watering during construction.

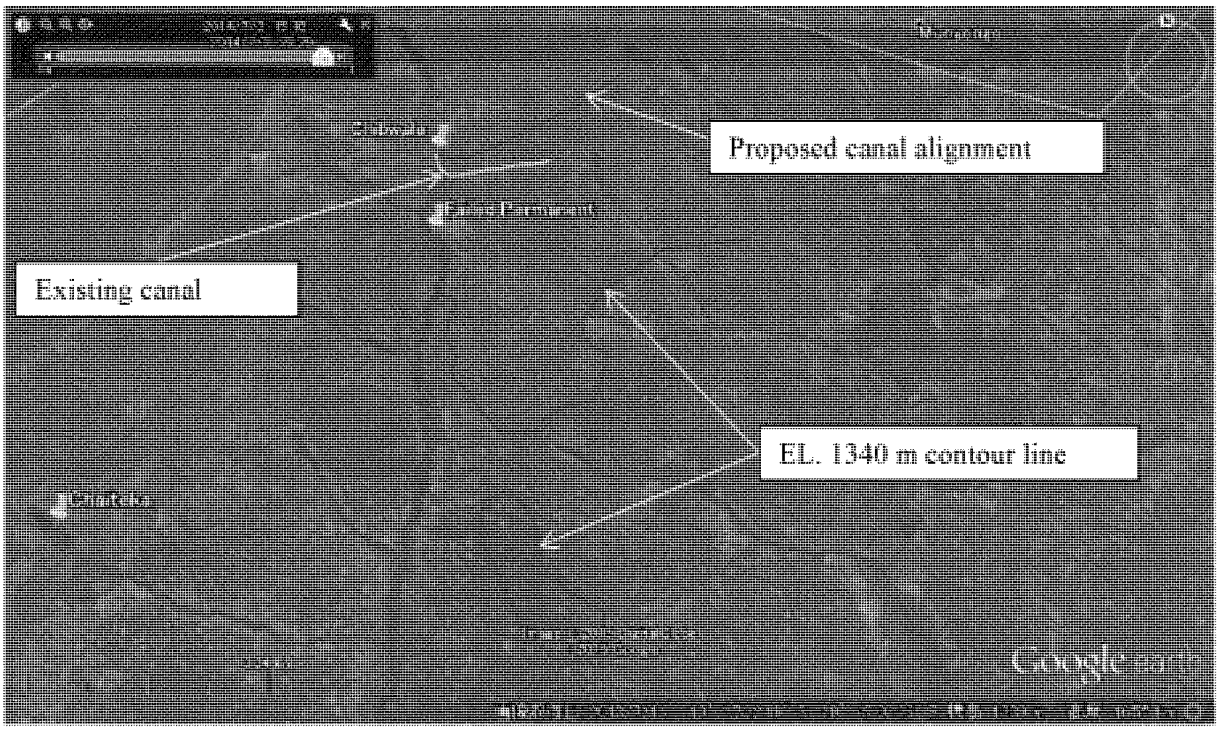


Figure 5-2 Investigation of terrain, beneficiary area, potential area, water use at upstream and downstream, residential area, etc. with Google Earth
Source: T-COBSI Project Team

(6) Potential area
Considering economy, potential area is desirable to be more than 5 has.

(7) Number of household
Considering required labor force, number of household should be more than 30. It is desirable to be more than 50.

(8) Farmers organization
If there is a farmers' organization, it is advantageous to mobilize farmers for construction and O&M.

(9) Available water source
The river/stream should be perennial and water flow quantity should be enough and stable.

(10) Water use of upstream and downstream.
There is no water user for irrigation within 1km downstream from the weir. Water right of downstream should be checked. Upstream water user should be checked if it affects intake water or not.

(10) Others
Consider if any problem of farming, marketing or gender issue.

5.3 Site Investigation

Site investigation will be conducted at each candidate site.

5.3.1 Items to be clarified by the investigation

1) Natural condition (water, weather, land-form, geology, soil, etc.)
2) Condition of water usage (irrigation, domestic water, fish pond, cattle, etc.)

3) Social, economic, and farming conditions of project areas
4) Intention of farmers in the project area
5) Construction condition

5.3.2 Investigation items

5.3.2.1 Natural Condition

(1) Meteorological Data

As the weather is one of the basic factors of an irrigation plan, the data collected over long period (10 years or more in principle, and 20 years or more with regard to data on temperature, consecutive no-rainy days and pan evaporation, which are closely related with the irrigation plan) at the representative meteorological stations in the area shall be investigated. When the necessary data are not available in the project area, those derived from similar meteorological conditions can be used.

Investigation items are classified in accordance with the type of plan as shown in **Table 4-1**. They shall be selected depending on the type of plan and need.

Table 5-1 Investigation items for each plan

Item		Classification of Plan		
		Farming plan	Irrigation water plan	Other facilities plan
Temperature	Mean temperature	○		
	Minimum temperature	○	○	
Precipitation	Daily precipitation	○	○	
	Monthly precipitation	○	○	
	Annual precipitation	○	○	
	Maximum hourly precipitation			○
Rainy days		○	○	
Sunshine duration		○	○	
Continuous droughty days		○	○	
Most frequent wind direction		○		○
Maximum wind velocity		○		○
Pan evaporation		○	○	

Source: Engineering manual for Irrigation and Drainage "Upland Irrigation". The Japanese Institute of Irrigation and Drainage, 1990

(2) Investigation of river conditions

Investigation of river condition should be executed on (i) water level and discharge, (ii) sedimentation, (iii) stream centerline, (iv) riverbed slope, (v) riverbed materials.

(i) Water level and discharge

Highest water level and representative water level in each month are required to be obtained. Highest water level is obtained by observing past flood mark and by interviewing the villagers. Representative discharge in each month is estimated from water level, flow velocity and cross-section.

(ii) Sedimentation

River sediment is measured in order to arrange for sand removal plan. Sediment at a river structure of vicinity area can be referred.

(iii) Stream centerline

The location of the weir should be selected at a site where the stream centerline is stable and

located near the riverbank where the intake is required.

(iv) Riverbed slope

Riverbed slope is an essential hydrological parameter and necessary to estimate discharge. Riverbed slope is obtained by surveying the elevation at 20m interval from 100m upstream to 100m downstream of the weir.

(v) Riverbed materials

Riverbed materials should be observed to estimate roughness coefficient. Value of roughness coefficient is shown in the **Table 5-2**.

Table 5-2 Roughness Coefficient of Natural Flow Canals

Materials and conditions of canals	Roughness Coefficient		
	Minimum	Standard	Maximum
Small canals on flat land			
1). Not weedy, straight. Neither cracks nor crevices are seen when water reaches the high water level	0.025	0.030	0.033
2) Weedy and stony. Neither cracks nor crevices are seen when water reaches the high water level	0.030	0.035	0.040
3) Not weedy but meandering. Some crevices and shallows are seen.	0.033	0.040	0.045
4) Some weeds and stones, meandering. Some abysses and shallows are seen.	0.035	0.045	0.050
5) Meandering. Some crevices and shallows are seen. The changes in gradients and cross-sections are few at low water level.	0.040	0.048	0.055
6) The same as 5) but stony.	0.045	0.050	0.060
7) Weeds and deep crevices are seen along moderate flow areas.	0.050	0.070	0.080
8) Area where weeds grow densely, deep crevices are seen, or many trees are present	0.075	0.100	0.115
Canals in mountain areas. No plants in canals. River banks are usually steep. Trees and shrubs along river banks are submerged when water reaches the high water level.			
1) Cobblestones and gravel on river bed	0.030	0.040	0.050
2) Large cobblestones on river bed	0.040	0.050	0.070
Large canals			
1) Constant cross sections without large cobblestones or shrubs	0.025		0.060
2) Rough and irregular cross sections	0.035		0.100

Source: Engineering Manual for Irrigation and Drainage "Canal Works". The Japanese Institute of Irrigation and Drainage 1987.

(3) Investigation on the influence of flood control

The condition of drainage discharges into rivers upstream and downstream during the ordinary flow should be investigated in order to find the influence of rise of water level by weir upon drainability upstream and downstream. Flood water level and flood pond area should be investigated to decide the height of weir.

(4) Investigation on the foundations

Investigation on the foundations are executed for items such as the structure and properties of the ground, bearing capacity of the ground, conditions of riverbed deposits, ground water level and flow condition of ground water.

Investigation on the foundations should be carried out in order to design suitable foundation structures

for the ground condition. Test pitting makes possible appraisal of strata and geology by the naked eye and to estimate bearing capacity.

(5) Topographical survey

Topographical survey for weirs should be done on the following items;

(i) Plane survey

Plane survey of the site is necessary not only for construction of the weir and intake but also for the planning and design of cofferdam. Curvature conditions of the river should be surveyed. It is desirable to draw contour lines on the map.

(ii) Longitudinal and cross section

Profile and cross section of the river are used for designing weir and hydraulic calculations.

(iii) Collection of topographic and other related maps

Prior to field investigations and surveys, topographic maps and other related maps around the scheme should be collected in order to prepare the investigation schedule, and to make a preliminary design.

5.3.2.2 Condition of Water Usage

Present condition of river utilization such as irrigation, hydropower, water rights, fishery and others should also be investigated.

Investigate rights regarding water sources in the project area and its periphery. Principal investigation items are: 1) Agricultural and other water rights, 2) Fishing rights, and 3) Regulation on the environment such as nature protection. Accurately investigate their contents.

5.3.2.3 Investigation on Socio-economic Conditions

(1) Investigation of socio-economic conditions

Investigate the total population, number of households, the labor force and income structure in industries, the major economic activities in the area, etc. to identify the roles of agriculture in the socio-economy situation of the area.

(2) Investigation of agricultural structure

Examine the constraints on the development of agricultural production in the area with respect to farm management, income, the marketing, water supply and farmers' consciousness of them.

① The investigation of farm production and income reveals those factors of land, labor, capital, crops produced and farming households which constitute agricultural production structure (scale, organization, capital composition, and differentiation of farmers). Also, investigate the farmers' economy and the profitability (production costs) of each crop. When the land and water-supply conditions constitute the constraints on the increasing farm productivity, examine their present conditions and the factors causing such problems.

② The investigation of marketing reveals the marketing and distribution of agricultural products focusing on the quantity and the prices of each crop for each season according to marketing and distribution channels, and offers a prospect for the demand and supply by crops as well as identification of the problems and measures.

③ The investigation of the water supply, reveals the current land and water utilization conditions and the past development process of land improvement, projects, the bodies managing the land improvement facilities, the property of water use facilities, customs of water use, and water

charges to identify the constraints on agricultural development in relation to the water supply.

5.3.2.4 Investigation on Farming and Cultivation Conditions

(1) Major crops and cultivation management systems

As basic data for future farming plans, recent changes in cropping, the cropping season and technology used for the currently cultivated major crops to identify problems of farming and cultivation techniques.

Investigation contents and method;

①Investigation of crops cultivated

a) Investigate the crops cultivated (summer and winter crops).

②Investigation of cropping season

Investigate the cropping calendar (sowing, transplanting, and harvesting seasons respectively) of each major crop by survey at the agricultural extension service offices, at sites, etc.

④ Investigation of cultivation technology

Investigate the present cultivation technology of major crops by survey at the agricultural extension service offices and at sites. Based on the investigation results identify farming and cultivation technological problems, and examine their countermeasures.

(2) Yield and amount of damages

Investigate the yield of present major crops and crop losses according to factors, and the yield of such crops to be introduced by the plan. In addition, examine the causes of damage affecting the present yield, the possibility of improvement, and the necessary countermeasures, and utilize them as the basic data for formulation of the farming plan and the calculation of the project economy.

(3) Conditions of livestock breeding .

Investigate the number of livestock, number of farmers keeping livestock, breeding scale, systems, production conditions, etc. to identify present problems and examine how to improve the situation.

5.3.2.5 Investigation of Farmers' Intentions

(1) Investigation method

Interview to the farmers.

(2) Investigation items

① Actual farming conditions
② Farming improvement measures
③ Intentions on improvement of agricultural infrastructure
④ Judgment items of the burden of the project cost
⑤ Intentions on operation and management of facilities
⑥ Other necessary items

5.3.2.6 Investigation of Related Projects

(1) Land improvement projects

In order to establish the design and the construction plan, examine whether there are any other agricultural infrastructure development projects, including those under planning, in such fields as the improvement of main irrigation and drainage facilities for agriculture, farm road improvement, soil dressing and under-drainage managed or financed by national or district governments or groups.

If there are any, investigate the features of their plan and design, the route selection, the structure, the construction year, and the conditions at the time of construction. In addition, investigate how land improvement districts, cities, towns, and villages, agricultural cooperatives and persons related with agriculture evaluate these projects by means of the analysis of the data in the plans and design specifications of these projects as well as by interviews.

(2) Other projects

①River improvement project

When there are improvement plans for rivers near the site or in the peripheral areas, investigate the route, the river width, the section, the gradient, the flood level, the ordinary water level, the riverbed level, the construction time, the unit drainage discharge, the submergence conditions in the district, how to acquire the land, etc. after the completion of the improvement work.

②Road improvement and new construction projects

When there are improvement and new construction projects of roads near the site or its peripheral areas, investigate the route, the width of the site, the structure, the construction time, how to acquire the land, etc.

③Water utilization project

When there are dam projects for power generation and flood control etc. and industrial water projects near the site or in its peripheral areas, investigate the contents of the plan for water utilization.

5.3.2.7 Construction Condition

Investigation for construction works should be conducted on the following items, which are necessary for construction planning.

Construction materials include cement, sand, gravel, stone, steel materials, bricks and timber etc. The supply situation of materials should be checked. Availability of local materials, necessity of transportation, availability of transportation and availability of tools should also be checked. Transportation of materials should be arranged if necessary. Minimum use of construction equipment is encouraged for small scale irrigation schemes. Number of skilled labor and unskilled labor should also be checked.

5.4 Basic of Irrigation Planning

5.4.1 Introduction

All field crops need soil, water, air and light (sunshine) to grow. The soil gives stability to the plants; it also stores the water and nutrients which the plants can take up through their roots. The sunlight provides the energy which is necessary for plant growth. The air allows the plants to "breathe".

Without water crops cannot grow. Too much water is not good for many crops either. Apart from paddy rice, there are only very few crops which like to grow "with their feet in the water". The most well-known source of water for plant growth is rain water. There are two important questions which come to mind: What to do if there is too much rain water? What to do if there is too little rain water?

If there is too much rain, the soil will be full of water and there will not be enough air. Excess water must be removed. The removal of excess water - either from the ground surface or from the root zone - is called drainage.

If there is too little rain, water must be supplied from other sources; irrigation is needed. The amount of irrigation water which is needed depends not only on the amount of water already available from rainfall, but also on the total amount of water needed by the various crops.

With respect to the need for irrigation water, a distinction can be made among three climatic situations:

1. Humid climates: more than 1200 mm of rain per year. The amount of rainfall is sufficient to cover the water needs of the various crops. Excess water may cause problems for plant growth and thus drainage is required.

2. Sub-humid and semi-arid climates: between 400 and 1200 mm of rain per year. The amount of rainfall is important but often not sufficient to cover the water needs of the crops. Crop production in the dry season is only possible with irrigation, while crop production in the rainy season may be possible but unreliable: yields will be less than optimal.

3. Semi-arid, arid and desert climates: less than 400 mm of rain per year. Reliable crop production based on rainfall is not possible; irrigation is thus essential. The two major factors which determine the amount of irrigation water which is needed are:

i. the total water need of the various crops

ii. the amount of rain water which is available to the crops

In other words: the irrigation water need is the difference between the total water need of the crops and the amount of rainfall which is available to the crops.

In many countries it is already well known what the crop water needs and irrigation water needs are of the most commonly grown crops. Such data can usually be obtained from the Extension Service, the Irrigation Department or Ministry of Agriculture. It is then not necessary to determine the crop and irrigation water need. However, there may be situations where it is not possible to obtain these data and it would thus be necessary to determine them on the spot.

5.4.2 Preparation of Basic Plan

(1) Basic plan

■ Based on the detailed investigation, farming plans, irrigation and water-source plans will integratedly, studied and a basic plan shall be formulated in the direction of the basic concept plan.

✓ The basic plan includes the determination of benefited areas, farming plans and water-source plans.

✓ The basic plan influences the facility plans and overall evaluation and benefit of the project. Therefore, the detailed investigation should be undertaken sufficiently to make the plan harmonious.

(2) Determination of the benefited areas

■ Determine the benefited area properly based on the detailed investigation, It is the fundamental of the plan formulation.

✓ The benefited areas, which are already delineated in the basic concept plan, are determined based on detailed investigations on the topography, geographical features, acreage, agricultural economical aspect, farmers' intentions, and related projects, with the method and scale of irrigation, and the smoothness of the irrigation facility management taken into consideration.

✓ Since the benefited area has a close relationship with the farming, irrigation and water-source plans, the balance with these factors shall be fully taken into account.

(3) Determination of farming program

■ A farming plan inclusive of the cultivation period, farming method and fertilization management which will be the basic factors for making the irrigation plan will be formulated.

✓ In the farming plan, the land-use plan applicable to the area will be determined. The management basis such as labor force and farmland on which the plan is prepared is subject to changes, and the supply and demand and the prices of crops also fluctuate. Therefore, the farming program has to be flexible enough to cope with changes in environmental and management conditions of the regions.

✓ The selection of the crops to be introduced shall fully reflect the intentions of the farmers as well as regional development and program, agriculture promotion area development plans and the expected supply and demand of the crops shall be studied for reference. The crops to be introduced will satisfy the following conditions.

- Crops which are in line with the agricultural promotion plan of the region and match the supply and demand situation.
- Crops which are suited to natural conditions and offer economic benefits.
- Crops whose cropping pattern is compatible with arable land and working condition of

farmers, as well as being efficient and reasonable.

- Crops whose cultivating method is feasible judging from the local agricultural technical level.

(4) Determination of irrigation method

■ Because the irrigation method is closely related to the water supply at the on-farm level, and affects the cost for facilities and maintenance, the most suitable irrigation method for the area by examining its location, farming conditions, and the water-supply situation shall be decided.

1) Classification of irrigation methods

Irrigation methods are mainly classified into following four groups:

- Sprinkler irrigation:
- Fixed pipe irrigation: Perforation piped irrigation and Drip irrigation
- Surface irrigation: Furrow irrigation, Border irrigation, Contour ditch irrigation and Basin irrigation
- Sub-soil water irrigation

2) Sprinkler irrigation method

This method sprays compressed water like rainfall on the soil using a sprinkler. Several types of sprinklers are available differing in the diameter of the spraying circle, the sprinkling type, and pressure. Generally, a surface or an underground fixed pipe is laid on the farming field, on which sprinkler heads are placed at certain intervals so that the sprinkling circles are overlapped, and even sprinkling can be expected. The method lessens the penetration and loss of supplied water into deep ground or penetration loss due to an uneven soil surface which often occurs in the surface irrigation method, but the sprinkling is easily deflected by wind. Compared with surface irrigation, it is suitable for frequent irrigation on a small scale, and requires less management.

3) Fixed pipe irrigation methods

①Perforated pipe irrigation method

This method uses perforated pipes or hoses made of aluminum, vinyl chloride, or polyethylene, placed on the field surface. The irrigation area formed a rectangle. The method employs relatively low pressure with a large irrigation intensity. Compared with the sprinkler irrigation, the spraying distance is short, and the pipes are arranged densely.

②Drip irrigation method

This method is also known as trickle irrigation. The method irrigates from drip nozzles (emitters) or drip holes made at a certain intervals on polyethylene pipes laid on the soil surface along a line of plants. Water is slowly and frequently dripped around the roots, and is decompressed by several pressure-reducing methods. The drip nozzles have a spiral fluid path in them and the partition tube has a porous orifice in it, both of which are decompressed when compressed water in the primary side passes through. In this irrigation method, only the drip points and nearby surface areas are wet, which

makes this method suitable for the smallest but frequent type of irrigation.

Features: ①An elevated soil moisture around the drip points increases the yield. ②Limited water supply only to crop roots saves water. ③High moisture around main root zone means low salinity and less damage even with salt-containing water. ④Low fluid rate in the pipe facilitates an even water supply. ⑤It is controlled with less labor force.

Generally the system operates on 1kg/cm^2 of terminal pressure, using a decompressor and a filter to prevent clogging.

4) Surface irrigation methods

① Furrow irrigation method

The method irrigates plant roots by water permeated from the side of the furrow. Supply channels are arranged at certain intervals between the moderately sloped furrow, and cause a fixed amount of water to flow. Water is retained for the minimum necessary time to secure water depth downstream to supply sufficient water to the roots, while upstream where water is retained for an excessive time, water penetration loss to the deeper layer cannot be avoided. The irrigation efficiency is influenced by geographical features, intake rate, furrow length, and discharge amount. To make a uniform slope of a furrow, construction machinery is required. -

② Border irrigation method

The field is divided into bands by low boundary ridges, and sloped to cause water to flow as a thin laminar flow. The deep layer penetration loss and irrigation efficiency are similar to those of the furrow irrigation method. Compared with the furrow irrigation method, it requires less labor force; whereas it requires greater amount of water and as the limitation factor is the slope, land leveling over a wider area is indispensable. It is often used for irrigating pasture land.

③ Contour ditch irrigation method

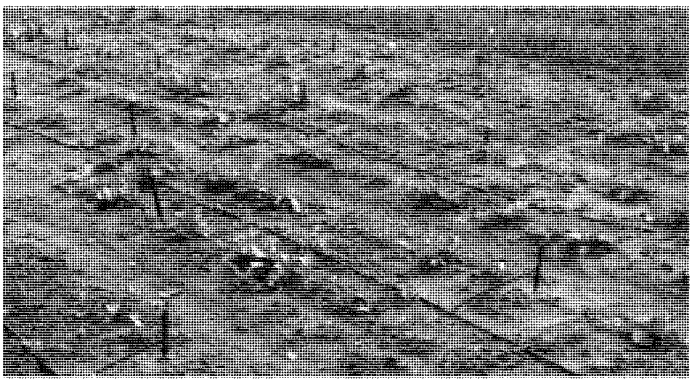
A ditch to introduce water is prepared with a slope of 1/1,000 along the contour line, and water is supplied from the turnout provided at the ditch. The method is applicable even on relatively irregular land, but the irrigation efficiency is low.

④ Basin irrigation method

According to this method, farm land will be flattened and enclosed by ridges. The irrigation water will be conveyed through irrigation canals or pipelines to irrigate the farmland intermittently.

Sprinkler Irrigation

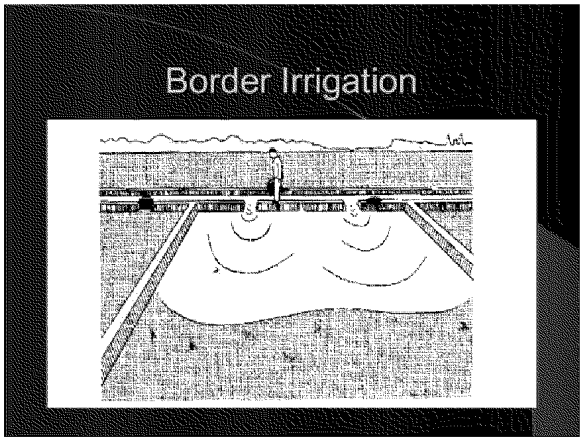
Center Pivot



Drip Irrigation

Basin Irrigation

Contour Ditch



Border Irrigation

5) Determination of the irrigation method

The irrigation method should be the most suitable for the area, and therefore shall be determined by examining following various conditions fully such as a farming program.

- Location

Geographical conditions such as the land slope and contour line, and meteorological conditions such as soil permeability and climate conditions such as wind velocity.

- Farming conditions

Cultivated crops: Restricted factors for determining the irrigation method according to the types of crops

Cultivation method: Plant density, furrowing method, crop rotation system

Level of grouping: Grouping of crops, possibility of cooperative management, level of mechanization

Farming Size: Size of farm management area, farming program, etc.

- Water-supply circumstances

Restriction of available water resources, water requirements and irrigation efficiency, etc.

- Economy, etc.

(5) Determination of irrigation plan

■ The irrigation plan is a fundamental in determining water resources and the dimension of irrigation facilities. Based on the careful studies of these factors, the basic figures requirement, multipurpose usage, and the amount of water shall be determined.

For details of the irrigation plan, refer to 4.3.3 "Irrigation Plan".

1) Determination of basic figures for estimating the water requirements

The soil moisture characteristics and moisture permeability of upland fields are investigated to determine the total readily available moisture (TRAM), daily consumptive use of water, irrigation interval days, and net amount of water to be replaced at each irrigation.

2) Determination of water requirement

Irrigation water shall be determined based on the proposed irrigation areas and available water resources, taking into account the fundamental figures of irrigation water requirements, daily rainfall, parameters of multipurpose usage, etc.

3) Study on Water Resources Dependency

An available water resource will be allocated to meet the estimated water requirements, and the required amount of each water-source will be studied.

(6) Determination of Water-source Plan

■ Based on the irrigation plan and the detailed investigation, the type, location of facility and size of water resources shall be decided.

✓ Water requirements (water-source dependency) calculated in the irrigation plan shall correspond to the allowable amount of water source in type and location. Then the discharge water balance of the source will be studied from the rainfall and river discharge to decide the design year and the size of the water-source facilities.

✓ For details of the water-source plan, refer to 4.3.3.6 Water-Source Plan.

5.4.3 Irrigation Plan

5.4.3.1 Basis of Water requirement Decision

■ Water requirements will be decided properly taking the climate of the benefited area, characteristics of soil and crops, and future direction of farming and cropping pattern into consideration.

✓ To formulate the irrigation plan, the characteristics of rainfall and soil shall be examined carefully, and it is important that the water-holding capacity of the soil should be properly used to increase

the ratio of effective rainfall in the water supply, and that the major dimension of the irrigation plan shall be decided.

✓ To improve the quality as well as the yield of crops, it is important to understand the characteristics of water relation for growing plants, so that the starting time of irrigation and the soil moisture need to be studied for each crop.

5.4.3.2 Water requirement

1) Procedure for calculation of water requirements*

■ The water requirement for supplemental irrigation is decided based on the meteorological characteristics, soil moisture and the characteristics of the benefited area and water consumption of upland crops to be irrigated.

**Refer to "FAO Irrigation and Drainage Paper NO.24, Crop Water Management, pg. 2, Calculation Procedures "*

✓ The procedure of estimating the water requirements for supplemental irrigation is shown in **Fig. 4-3** The calculation of the water requirements shall be proceeded by the determination of the estimated daily consumption of water, irrigation intervals, and net amount of water to be replaced, and these items are important figures in the irrigation plan. These figures will be decided based on the climate, soil moisture and the characteristics in the benefited areas and characteristics consumptive use of water by crops to be irrigated.

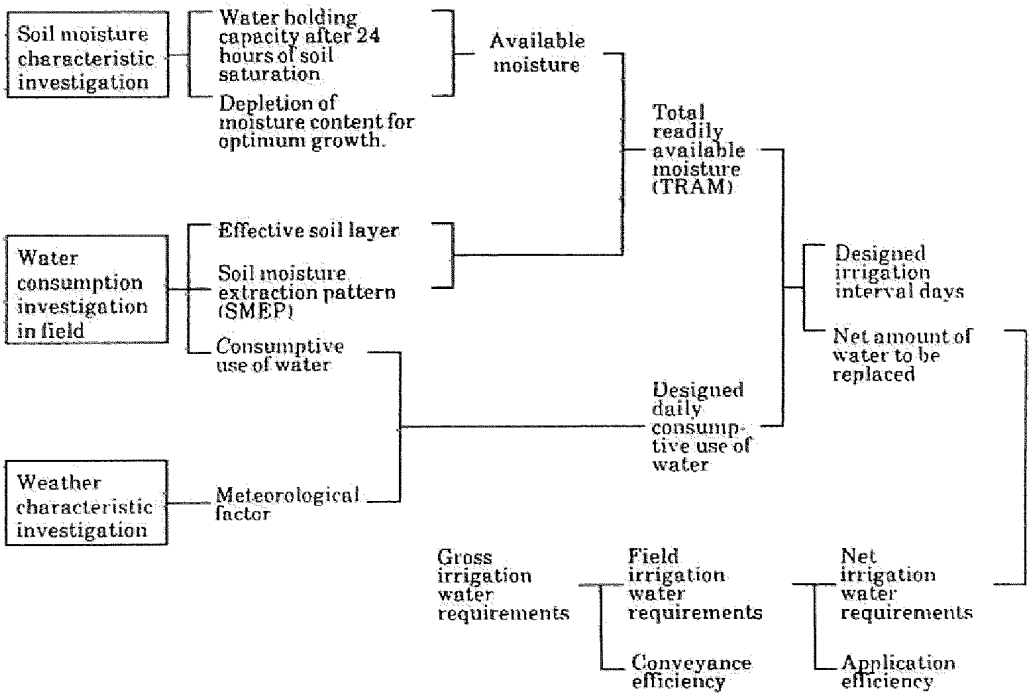


Fig5-3 Procedure of water requirement calculation

Source: Engineering Manual for Irrigation and Drainage "Upland Irrigation". The Japanese Institute of Irrigation and Drainage, 1990

- ✓ Field irrigation water requirements and gross irrigation water are calculated based on the net amount of water to be replaced and irrigation efficiency.
- ✓ The designed daily consumptive use of water is decided from the consumptive use obtained through field investigations on crop consumptive use, and the weather characteristics.

5.4.3.3 Crop Water requirements

Crops need water for transpiration and evaporation. The plant roots suck or extract water from the soil to live and grow. The main part of this water does not remain in the plant, but escapes to the atmosphere as vapour through the plant's leaves and stem. This process is called **transpiration.** Transpiration happens mainly during the day time.

Water from an open water surface escapes as vapour to the atmosphere during the day. The same happens to water on the soil surface and to water on the leaves and stem of a plant. This process is called **evaporation**.

The water need of a crop thus consists of transpiration plus evaporation. Therefore, the crop water need is also called **"evapotranspiration".**

The water need of a crop is usually expressed in mm/day, mm/month or mm/season.

Suppose the water need of a certain crop in a very hot, dry climate is 10 mm/day. This means that each day the crop needs a water layer of 10 mm over the whole area on which the crop is grown. It does not mean that this 10 mm has to indeed be supplied by rain or irrigation every day.

It is, of course, still possible to supply, for example, 50 mm of irrigation water every 5 days. The irrigation water will then be stored in the root zone and gradually be used by the plants: every day 10 mm.

The crop water requirement mainly depends on:

· **the climate:** for example, in a sunny and hot climate crops need more water per day than in a cloudy and cool climate.

· **the crop type:** crops like rice or sugarcane need more water than crops like beans and wheat

· **the growth stage:** grown crops need more water than crops that have just been planted.

(1) The Influence of The Climate on Crop Water requirement

A certain crop grown in a sunny and hot climate needs per day more water than the same crop grown in a cloudy and cooler climate. There are, however - apart from sunshine and temperature - other climatic factors which influence the crop water need. These factors are the humidity and the wind speed. When it is dry, the crop water requirement is higher than when it is humid. In windy climates the crops will use more water than in calm climates.
The effect of these four climatic factors on the water need of the crop is shown in **Table 4-3.**

Table 5-3 Effect of Major Climate Factors on Crop Water Requirement

Climatic Factor	Crop Water Requirement	
	High	Low
Sunshine	Sunny	Cloudy
Temperature	Hot	Cool

Humidity	Low (dry)	High (humid)
Wind speed	High (windy)	Low (little wind)

Source: Irrigation Water Management Training Manual No.3 "irrigation Water Need". FAO, 1986

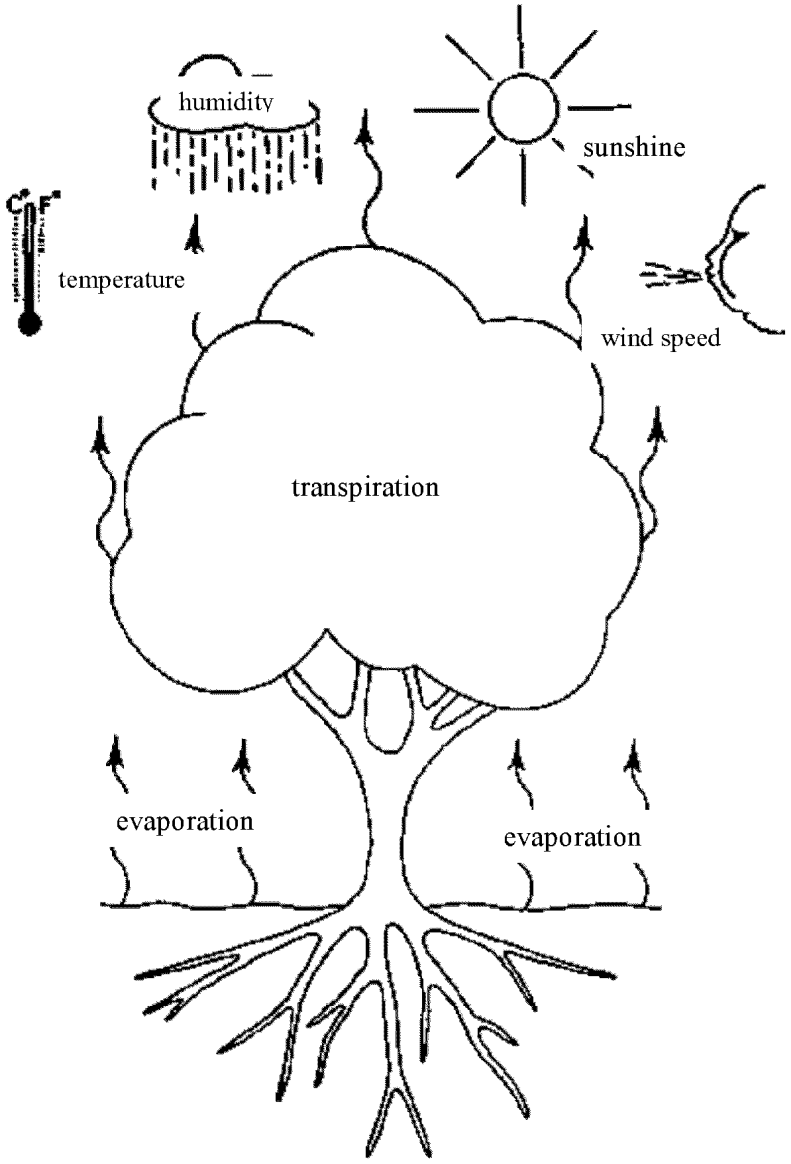


Figure-5-4 Major climatic factors influencing crop water requirement

Source: Irrigation Water Management Training Manual No.3 "irrigation Water Need". FAO, 1986

The highest crop water requirement is thus found in areas which are hot, dry, windy and sunny. The lowest value is found when it is cool, humid and cloudy with little or no wind.

From the above it is clear that one crop grown in different climatic zones will have different water requirement. For example, a certain maize variety grown in a cool climate will need less water per day than the same maize variety grown in a hotter climate.

It is therefore useful to take a certain standard crop or reference crop and determine how much water this crop needs per day in the various climatic regions. As a standard crop or reference crop grass has been chosen.

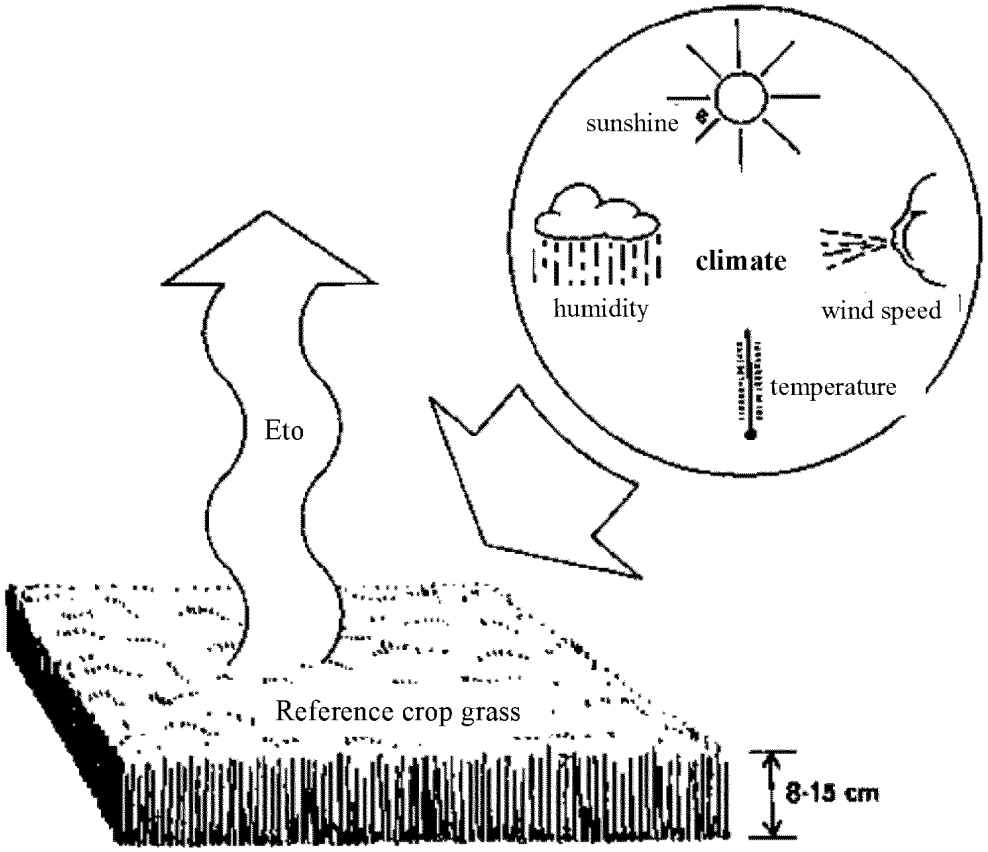


Figure 5-5 Reference crop evapotranspiration

Source: Irrigation Water Management Training Manual No.3 "irrigation Water Need". FAO, 1986

Table 5-4 indicates the average daily water needs of this reference grass crop. The daily water needs of the grass depend on the climatic zone (rainfall regime) and daily temperatures.

Table 5-4 Average Daily Water Requirement of Standard Grass During Irrigation Season

Climatic zone	Mean daily temperature		
	low	medium	high
	Less than 15°C	16 – 25°C	More than 25°C
Desert/arid	4 – 6	7 – 8	9 – 10
Semi arid	4 – 5	6 - 7	8 – 9
Sub-humid	3 – 4	5 – 6	7 – 8
Humid	1 - 2	3 - 4	5 – 6

Source: Irrigation Water Management Training Manual No.3 "irrigation Water Need". FAO, 1986

For example, the standard grass crop grown in a semi-arid climate with a mean temperature of 20°C needs approximately 6.5 mm of water per day. The same grass crop grown in a sub-humid climate with

a mean temperature of 30°C needs some 7.5 mm of water per day.

This daily water need of the standard grass crop is also called "reference crop evapotranspiration".

(2) Influence of The Crop Type on The Crop Water Requirement

The influence of the crop type on the crop water need is important in two ways:

1. The crop type has an influence on the daily water needs of a fully grown crop; i.e. the peak daily water requirement: a fully developed maize crop will need more water per day than a fully developed crop of onions.

2. The crop type has an influence on the duration of the total growing season of the crop. There are short duration crops, e.g. peas, with a duration of the total growing season of 90-100 days and longer duration crops, e.g. melons, with a duration of the total growing season of 120-160 days. And then there are, of course, the perennial crops that are in the field for many years, such as fruit trees.

While, for example, the daily water need of melons may be less than the daily water need of peas, the seasonal water need of melons will be higher than that of peas because the duration of the total growing season of melons is much longer.

1) Influence of Crop Type on the Daily Crop Water Requirement

In the previous section it has been indicated how the daily water requirement of standard grass can be estimated. In this section it will be explained how the daily water requirements of other crops can be estimated using as a basis the daily water requirement of the standard grass.

It will be easy to understand that a fully grown maize crop - with its large leaf area - will use more water per day than, for example, a fully grown crop of radishes or onions; that is when the two crops are grown in the same area.

When determining the influence of the crop type on the daily crop water requirement, reference is always made to a fully grown crop; the plants have reached their maximum height; they optimally cover the ground; they possibly have started flowering or started grain setting. When the crops are fully grown their water need is the highest. It is the so-called "peak period" of their water needs.

For the various field crops it is possible to determine how much water they need compared to the standard grass. A number of crops need less water than grass, a number of crops need more water than grass and a number of crops need more or less the same amount of water as grass.

2) Influence of Crop Type on the Seasonal Crop Water Requirement

The crop type not only has an influence on the daily water need of a fully grown crop, i.e. the daily peak water requirement, but the crop type also has an influence on the duration of the total growing season of the crop, and thus on the seasonal water requirement.

Data on the duration of the total growing season of the various crops grown in an area can best be obtained locally. These data may be obtained from, for example, the seed supplier, the Extension Service, TSB or Ministry of Agriculture.

The duration of the total growing season has an enormous influence on the seasonal crop water requirement. There are, for example, many rice varieties, some with a short growing cycle (e.g. 90 days) and others with a long growing cycle (e.g. 150 days). This has a strong influence on the seasonal rice water requirement: a rice crop which is in the field for 150 days will need in total much more

water than a rice crop which is only in the field for 90 days. Of course, for the two rice crops the daily peak water need may still be the same, but the 150 day crop will need this daily amount for a longer period. The time of the year during which crops are grown is also very important. A certain crop variety grown during the cooler months will need substantially less water than the same crop variety grown during the hotter months.

(3) Influence of the Growth Stage of the Crop on Crop Water Requirement

A fully grown maize crop will need more water than a maize crop which has just been planted. As has been discussed before, the crop water need or crop evapotranspiration consists of transpiration by the plant and evaporation from the soil and plant surface. When the plants are very small the evaporation will be more important than the transpiration. When the plants are fully grown the transpiration is more important than the evaporation.
Figure 5-6 shows in a schematic way the various development or growth stages of a crop.

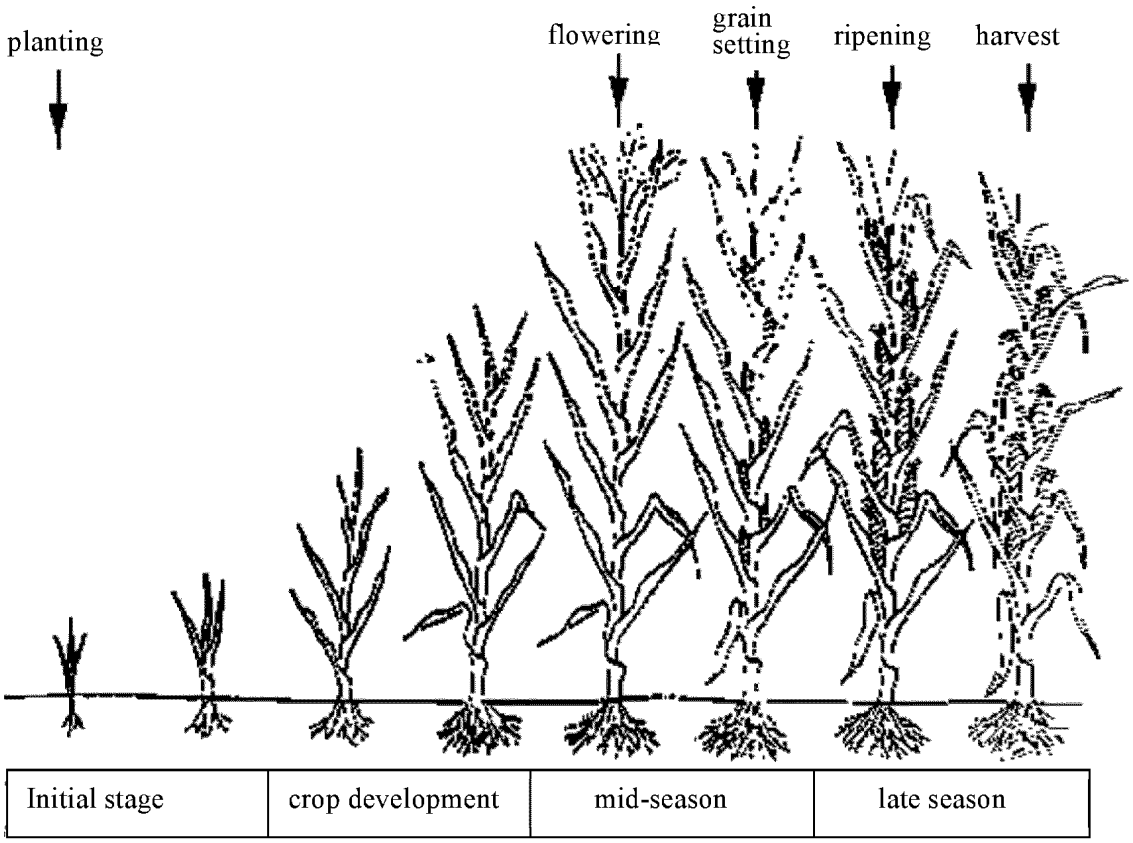


Figure 5-6 Growth stage of a crop

Source: Irrigation Water Management Training Manual No.3 "irrigation Water Need". FAO, 1986

At planting and during the initial stage, the evaporation is more important than the transpiration and the evapotranspiration or crop water requirement during the initial stage is estimated at 50 percent of the crop water requirement during the mid - season stage, when the crop is fully developed.

During the so-called crop development stage the crop water requirement gradually increases from 50 percent of the maximum crop water requirement to the maximum crop water requirement. The maximum crop water requirement is reached at the end of the crop development stage which is the beginning of the mid-season stage.

With respect to the late season stage, which is the period during which the crop ripens and is harvested, a distinction can be made between two groups of crops:

Fresh harvested crops: such as lettuce, cabbage, etc. With these crops the crop requirement need remains the same during the late season stage as it was during the mid-season stage. The crops are harvested fresh and thus need water up to the last moment.

Dry harvested crops: such as cotton, maize (for grain production), sunflower, etc. During the late season stage these crops are allowed to dry out and sometimes even die. Thus their water requirement during the late season stage is minimal. If the crop is indeed allowed to die, the water needs are only some 25 percent of the crop water need during the mid-season or peak period. Of course, no irrigation is given to these crops during the late season stage.

5.4.3.4 Effective Rainfall

Apart from soil, air and sunlight, crops need water to grow. How much water the various crops need has been explained in previous section.

This water can be supplied to the crops by rainfall (also called precipitation), by irrigation or by a combination of rainfall and irrigation.

If the rainfall is sufficient to cover the water requirements of the crops, irrigation is not required.

If there is no rainfall, all the water that the crops need has to be supplied by irrigation.

If there is some rainfall, but not enough to cover the water requirements of the crops, irrigation water has to supplement the rain water in such a way that the rain water and the irrigation water together cover the water requirements of the crop. This is often called supplemental irrigation**:** the irrigation water supplements or adds to the rain water.

Not all rain water which falls on the soil surface can indeed by used by the plants. Part of the rain water percolates below the root zone of the plants and part of the rain water flows away over the soil surface as run-off. This deep percolation water and run-off water cannot be used by the plants. In other words, part of the rainfall is not effective. The remaining part is stored in the root zone and can be used by the plants. This remaining part is the so-called effective rainfall. The factors which influence which part is effective and which part is not effective include the climate, the soil texture, the soil structure and the depth of the root zone.

If the rainfall is high, a relatively large part of the water is lost through deep percolation and run-off.

Deep percolation: If the soil is still wet when the next rain occurs, the soil will simply not be able to store more water, and the rain water will thus percolate below the root zone and eventually reach the groundwater. Heavy rainfall may cause the groundwater table to rise temporarily.

Run-off: Especially in sloping areas, heavy rainfall will result in a large percentage of the rainwater being lost by surface run-off.

Another factor which needs to be taken into account when estimating the effective rainfall is the variation of the rainfall over the years. Especially in low rainfall climates, the little rain that falls is often unreliable; one year may be relatively dry and another year may be relatively wet.

In many countries, formulae have been developed locally to determine the effective precipitation. Such

formulae take into account factors like rainfall reliability, topography, prevailing soil type etc. If such

formulae or other local data are available, they should be used.

5.4.3.5 Decision of designed water requirements

(1) Calculation of Crop Water Requirement

In the process for estimating the irrigation water requirements, the reference crop evapo- transpiration (ETo) for upland crops could be estimated using the "CROPWAT for Windows Computer Software" [1], being popular in the agricultural development plan in Africa, which is based on the FAO Penman-Monteich Equation. On the other hand, the ETo for paddy rice could be estimated using the modified Penmam Methods. The Penman-Monteith equation is given by the following equation:

$$ETo = \frac{0.408\,\Delta(Rn - G) + \gamma \dfrac{900}{T + 273} U2(es - ea)}{\Delta + \gamma(1 + 0.34u2)}$$

Where;

ETo	=	Reference evapo-transpitation (mm/day)
Rn	=	Net radiation at the crop surface (MJ/m^2per day)
G	=	Soil heat flux density (MJ/m^2per day)
T	=	Mean daily air temperature at 2 m height (℃)
U2	=	Wind speed at 2 m height (m/sec)
Es	=	Saturation vapour pressure (kpa)
Ea	=	Actual vapour pressure (kpa)
Es – ea	=	Saturation vapour pressure deficit (pka)
△	=	Slope of saturation vapor pressure curve at temperature T (kpa/℃)
γ	=	Psychometric constant (kpa/℃)

Crop water requirements (ETc/CWR) were estimated by multiplying ETo mentioned in the above by a crop coefficient (Kc), that is:

ETc = ETo x Kc

Where;

ETc/CWR	=	Crop water requirements (mm/day)
ETo	=	Reference crop evapo-transpiration (mm/day)
Kc	=	Crop coefficient

Crop coefficient:

The relationship between the reference grass and the crop actually grown is given by the crop coefficient.

Fully developed maize, with its large leaf area will be able to transpire, and thus use, more water than the reference grass crop: Kc, maize is higher than 1. Cucumber, also fully developed, will use less water than the reference grass crop: Kc, cucumber is less than 1

A certain crop will use more water once it is fully developed, compared to a crop which has just recently been planted.

The climate influences the duration of the total growing period and the various growth stages. In a cool climate a certain crop will grow slower than in a warm climate.

Thus, to determine the crop factor Kc, it is necessary, for each crop, to know the total length of the growing season and the lengths of the various growth stages.
The determination of the Kc values for the various growth stages of the crops involves several steps:
Step 1 - Determination of the total growing period of each crop
Step 2 - Determination of the various growth stages of each crop
Step 3 - Determination of the Kc values for each crop for each of the growth stages

Standard figures of Kc for various crops are sown in the FAO paper 56.

(2) Cropping Patterns

Cropping patterns are planned to calculate crop water requirements and irrigation water requirements, considering topography, water availability, soil conditions, current farming practices, marketing conditions, etc. around each areas

Table 5-5 Sample Cropping Pattern

Crops	area (ha)	%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Green Maize	10.00	50												
Tomato	4.00	20												
Egg plant	1.00	5												
Rape	3.00	15												
Cabbage	1.00	5												
Okura	1.00	5												
Total	20.00	100			5	5	5	90	100	100	85	75	5	

Source: T-COBSI Project Team

(3) Estimation of Irrigation Water Requirements

In estimating irrigation water requirements applying the "CROPWAT" equation mentioned above, following procedures and assumptions are taken into considerations;

- Meteorological data

The data collected over long period (10 years or more in principle, and 20 years or more with regard to data on temperature, consecutive no-rainy days and pan evaporation, which are closely related with the irrigation plan) at the representative meteorological stations in the area shall be investigated. When the necessary data are not available in the project area, those derived from similar meteorological conditions can be used. Meteorological data of FAO-CLIMWAT can be used for CROPWAT.

- Crop coefficient

Crop coefficients for maize and upland crop are referred to the authorized values in the computer program, while those for paddy rice are quoted from FAO Technical paper NO. 24

- Effective rainfall

A number of empirically determined formulae can be used. They have been developed under a given set of conditions which may be very different from those under which they are to be applied. Their use elsewhere therefore remains doubtful.

According to FAO-CROPWAT, "In general, the efficiency of rainfall will decrease with increasing rainfall. For most rainfall values below 100 mm/month, the efficiency will be approximately 80%. Unless more detailed information for local conditions, it is suggested to select the Option "Fixed percentage" and give 80% as requested value".

In Northern, Luapula and Muchinga district, monthly precipitation in the dry season is less than 100 mm. Therefore, in this study, 80% is given as rainfall efficiency.

Table 5-6 Result of calculation

MBL 2-7 Kawama	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Precipitation deficit												
1. MAIZE (Green)	0	0	0	0	0	25.5	114.1	244	231.6	44.4	0	0
2. Tomato MBL2-7	0	0	0	0	0	51.1	141	233.4	218.5	11.8	0	0
3. Egg plant	0	0	0	23.4	153.7	91.5	0	0	0	0	0	0
4. Rape	0	0	0	0	0	80.2	184.8	153.7	0	0	0	0
5. CABBAGE MPR	0	0	0	0	0	0	68.4	169.1	217.7	205	5.2	0
6. Okura MBL	0	0	0	0	0	0	91.4	205.2	191.5	0	0	0
Net scheme irr.req.												
in mm/day	0	0	0	0	0.2	1.3	3.9	6.8	6	1.1	0	0
in mm/month	0	0	0	1.2	7.7	39.6	121	210.4	180	34.8	0.3	0
in l/s/h	0	0	0	0	0.03	0.15	0.45	0.79	0.69	0.13	0	0
Irrigated area (% of total area)	0	0	0	5	5	90	95	95	80	75	5	0
Irr.req. for actual area (l/s/h)	0	0	0	0.09	0.57	0.17	0.48	0.83	0.87	0.17	0.02	0

Source: T-COBSI Project Team

(4) Irrigation Efficiency

■ For deciding designed water requirements, water conveyance losses from water source to the field, and various water losses due to spraying in the field is added properly to the designed parameters for irrigation water requirements.

Water losses are obtained from irrigation efficiency which includes application and conveyance efficiencies in the field. It is decided on the reference the values shown in **Table 5-7**

Irrigation efficiency (IE) :

Irrigation efficiency is calculated by following formula:

Ep = Ea x Eb x Ec

Irrigation efficiency: Ep

Conveyance efficiency Ec: ratio of quantity of water at inlet of a block of field / intake water at source

Field canal efficiency Eb: ratio of quantity of water at field inlet / a block of field

Application efficiency Ea: ratio of quantity of water directory available to the crop / field inlet

Distribution efficiency Ed = Ec x Eb

Field efficiency Ef = Eb x Ea

Table 5-7 shows values determined by international institutes.
According to the table below, following coefficients are adopted in this study.
Ed = 0.3, Ea = 0.6
Ep = 0.6 x 0.3 = 0.18

Table5-7 Irrigation efficiency Ec, Eb, Ed, and Ea

Conveyance Efficiency (Ec)			ICID/ILRI
Continuous supply with no substantial change in flow			0.9
Rotational supply in projects of 3,000 – 7,000 ha and rotation areas of 70 – 300 ha, with efficient management			0.8
Rotational supply in large schemes (>10,000ha) and small schemes (<1,000 ha) with respective problematic communication and less effective management: Based on predetermined schedule			0.7
Based on advance request			0.65
Field Canal Efficiency (Eb)			
Blocks larger than 20 ha: unlined			0.8
lined or piped			0.9
Blocks up to 20 ha: unlined			0.7
lined or piped			0.8
Distribution efficiency (Ed = Eb x Ec)			
Average for rotational supply with management and			
Communication adequate			0.65
sufficient			0.55
insufficient			0.40
poor			0.30
Field Application Efficiency (Ea)	USDA	USSCS	
Surface methods			
Light soils	0.55		
Medium soils	0.70		
Heavy soils	0.60		
Graded border		0.60-0.75	0.53
Basin and level border		0.60-0.80	0.58
Contour ditch		0.50-0.55	
furrow		0.55-0.70	0.57
corrugation		0.50-0.70	
Subsurface		Up to 0.80	
Sprinkler, hot dry climate		0.60	
Moderate climate		0.70	
Humid and cool		0.80	0.67
Rice			0.32

ICID: International Committee of Irrigation and Drainage
ILRI: International Institute for Land Reclamation and Improvement
USDA: United States Department of Agriculture
USSCS: United States Soil Conservation Service

(5) Irrigation Water Requirements

Irrigation water requirements are classified into net irrigation water requirements and gross irrigation water requirements including water losses. They are the base for designing the capacity of irrigation facilities and are calculated by following expressions.

Net irrigation water requirements (NWR):

Net irrigation water requirements (NWR) will be calculated by

deducting the effective rainfall estimated on the 10-day basis by following equation;

NWR = ETc - Re

Where;

NWR : Net irrigation requirements (mm/day)
ETc : Crop evapo-transpiration (mm/day)
Re : Effective rainfall (mm)

Gross irrigation water requirements (GWR):

Gross irrigation water requirements (GWR) will be calculated by taking into consideration overall irrigation efficiencies (IE). The GWR will be estimated by the following equation.

GWR= NWR/IE

Where;

GWR : Gross irrigation water requirements (mm/day)
NWR : Net irrigation water requirements (mm/day)
IE : Overall irrigation efficiency

Example

Maize, 2nd decade of September : ETc = 8.69 mm/day, IE = 0.18, Re = 0mm

GWR = 8.69 / 0.18 = 48.28 mm/day

for 1 ha,

Q = 48.28 / 1000 x 10000 / 86400 = 0.0056 m3/s = 5.6 l/s

(6) Irrigation Water Requirements for System Capacity

Irrigation water requirements (IWR) to plan the system capacity will be determined by taking into consideration the time of irrigation hours per day and working day per week. The following equation will be used for the determination of the IWR:

IWR = GWR x A x 10,000 /(Hr x 3,600) x 7/v

Where,

IWR : Irrigation water requirements for system capacity (lit./sec)
GWR : Gross irrigation water requirements (mm/day)
A : Irrigation area (ha)
Hr : Water supply hours per day (hrs)
V : Working days per week (days)

Example

GWR = 48.28 mm/day, A = 1 ha, Hr = 8 hrs, V = 5 days

IWR = 48.28 x 1 x 10000 / (8 x 3600) x 7 / 5 = 23.47 lit/s/ha

5.4.3.6 Water-Source Plan

(1) Designed year for planning

- The designed year for planning is basically a drought year which after comes around once in a decade. It should be judged based on the meteorological and rainfall records of a long period.

To prepare an irrigation plan, the designed year for planning should be set, and the possibility of water utilization in the year is studied to prepare a plan which applicable to the water source (including expansion of water source). The designed year for planning is usually a drought year which comes around every ten years.

1) Water from river run - off

The designed year for planning years is a drought year, coming about once in ten years (probability of 1/10 year).

2) Other water sources

The designed year is decided from statistical processing of the consecutive drought days and effective rainfall amount during irrigation period with probability of 1/10. The decision of designed year should be based on meteorological and rainfall data of more than 20 years as a rule.

(2) Water source plan

- Water source plan is to examine technical possibility of various water sources as rivers, groundwater, reservoirs, and others and to decide the most economical water source according to the irrigation method and the water requirements.

(Explanation)

Amount of available water will be obtained from data of a long period, and its statistical processing is used to secure the water source and the plan itself. As far as technology allows, many water sources should be compared and examined. To optimize water from rivers with low drought discharge, it is necessary to install a farm pond between water source and the irrigation area, and examine water source facilities about the extension of pump operation, and the reduction of the pump capacity. A pump is supposed to operate 24 hours.

To decide a water source plan, a cropping pattern and crop intensity are also examined to use water source efficiently.

In addition, in some structures of irrigation facilities and water management system, operation loss in the irrigation system is expected. Such losses should be recognized and available water source must he sufficient to cover them.

(3) Whole System Plan

- Irrigation systems from the field to the water source for the upland irrigation includes on-farm irrigation, the water distribution, and the water conveyance systems.
- These three systems relates closely each other, and their harmonious connection with emphasis on economy, function and safety is desired in planning of irrigation systems.

1) Composition of the systems

① On-farm irrigation system

On-farm irrigation system is a general item for valves (including diversion valves) controlling a plurality of sprinkling blocks and other secondary facilities.

②Water distribution system

Water distribution systems is a general term for a series of facilities from a farm pond to the on-farm

irrigation systems.

③ Water conveyance system

Water conveyance system is a general term for a series of facilities from the water source to the water distribution system.

5.4.3.7 On - farm Irrigation System Plan

(1) Decision of furrow length and width

In furrow irrigation, furrow length is restricted by irrigation application efficiency, and soil maintenance. Maximum furrow length should be the length which allows water to reach without soil erosion or great deep zone loss. The larger the furrow discharge, or the smaller the intake rate, the longer the furrow becomes.

To improve labor efficiency of water distribution at one time, a longer furrow is preferable. However, there is a certain limitation in relation with the irrigation application efficiency.

Table 5-8 shows an example of maximum furrow length of different soils. The maximum furrow length of sandy soil, which has small water-holding capacity and large intake rate, is 10m or less. In terms of irrigation labor, furrow irrigation is not appropriate for sandy soil.

Table 5-8 Example of maximum furrow length of different soils

Soil	Root zone depth	One-time irrigation volume	Maximum furrow length
Sandy soil	40cm	16mm	4m
Volcanic ash soil	40cm	44mm	29m
Sandy loam	40cm	34mm	36m
Loam	40cm	38mm	99m
Clay	40cm	44mm	121m

Note: Furrow inclination is 10%. Source: Engineering Manual for Irrigation and Drainage Upland Irrigation, The Japanese Institute of Irrigation and Drainage 1990.

(2) Distribution Method of Irrigation Water

a) General Methods of Water Distribution

Following two types of water distribution methods are generally applied at present;

- Simultaneous distribution, and
- Rotational distribution

1) Simultaneous Distribution

This method involves simultaneous supply of water to all the canals.

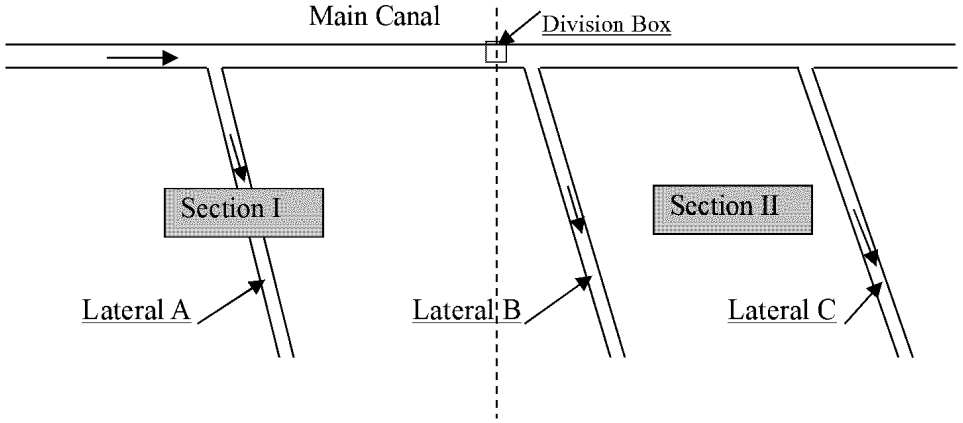
2) Rotational Distribution

Rotational distribution is practiced by rotating the supply of water to different areas. Under this method there are three practices as shown below, namely:

- Rotation by section in main canal
- Rotation by section or turnouts in the lateral/feeder canals
- Rotation by section in the farm ditch

Rotation by Section in Main Canal

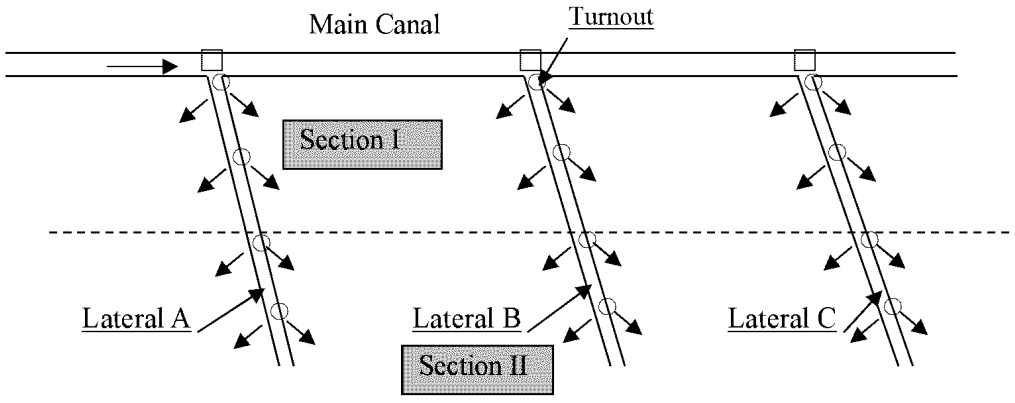
Irrigation water is conveyed by rotation to different sections in the main canal (refer to the following figure). This method requires bigger capacities for both conveyance and distribution systems.



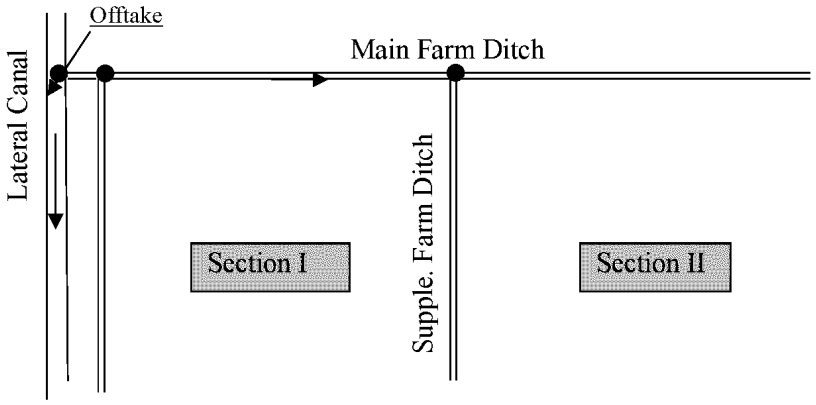
Generally, 3-day to 7-day rotational water supplies are adopted in the small scale irrigation schemes, so that irrigation interval in each scheme should be carefully checked and determined, based on the soil characteristics, estimated crop water requirement, canal and pump capacity, etc.

Rotation by Section or Turnouts in Lateral/Feeder Canals

The main canal conveys a continuous flow while the water is rotated by the section or turnouts of the lateral/feeder canal (refer to the following figure)



Rotation by Section in Farm Ditch
Water is rotated only in rotation area in the farm ditch, and conveyance of water in the main canal and lateral/feeder canals are continuous.



b) Comparison on the Water Distribution Methods

1) Advantages of Rotational Distribution Methods
Advantages of rotational water distribution are as follows;

- Water can be reasonably regulated and evenly distributed over the upper, middle and lower reaches of canal systems to meet the requirements for reducing and/or eliminating the droughts in the spot areas, when the water resources is scarce.
- It may save water which can be used for either extension of new irrigation areas or can be supplied for fish culture uses.
- Furthermore, the farmers will retain confidence in getting timely delivery of a limited amount of irrigation water during dry season and drought year.

2) Advantages of Simultaneous Water Distribution Methods
When the water resource is abundant, this method has the following advantages.

- The investment in the irrigation system is less because of fewer water control structures and measuring devices in the system.
- Less labour is used in simultaneous irrigation as compared with rotational irrigation.

5.4.3.8 Irrigation Schedule

(1) Introduction

The irrigation schedule indicates **how much** irrigation water has to be given to the crop, and **how often or when** this water is given.
How **much** and how **often** water has to be given depends on the **irrigation water requirement** of the crop. How to determine the irrigation water requirement has been discussed in 4.4.3.5. The irrigation water requirement is defined as the crop water requirement minus the effective rainfall. It is usually expressed in mm/day or mm/month. When, for example, the irrigation water need of a certain crop, grown in a hot, dry climate is 8 mm/day, this means that each day the crop needs a water layer of 8 mm over the whole area on which the crop is grown. This water has to be supplied by means of irrigation.
An irrigation water need of 8 mm/day, however, does **not** mean that this 8 mm has to be supplied by irrigation **every day.** In theory, water could be given daily. But, as this would be very time and labour consuming, it is preferable to have a longer irrigation interval. It is, for example, possible to supply 24 mm every 3 days or 40 mm every 5 days. The irrigation water will then be stored in the root zone and gradually be used by the plants: every day 8 mm. The irrigation interval has to be chosen in such a way that the crop will not suffer from water shortage.

In **Figure 5-7** it can be seen that, on this soil, the plants start to suffer after approximately one week. Irrigation water should be given before this happens, in order to allow for optimal production. In general this means that irrigation should at the latest take place when approximately half of the available water content of the root zone has been used by the plants. When, for example (**Figure 5-8**), irrigation water is given on day 5, on day 9, on day 13, etc., the plants will not suffer from water shortage.

In principle, the amount of irrigation water given in **one** irrigation application (irrigation depth) is the amount of water used by the plants since the previous irrigation.

The amount of irrigation water which can be given during one irrigation application is however **limited.**

The **maximum amount** which can be given has to be determined and may be influenced by:

- the soil type
- the root depth
- the irrigation method.

The **soil type** influences the maximum amount of water which can be stored in the soil per metre depth. Sand can store only a little water or, in other words, sand has a low available water content. On sandy soils it will thus be necessary to irrigate frequently with a small amount of water. Clay has a high available water content. Thus on clayey soils larger amounts can be given, less frequently.

The **root depth** of a crop also influences the maximum amount of water which can be stored in the root zone. If the root system of a crop is shallow, little water can be stored in the root zone and frequent - but small - irrigation applications are needed. With deep rooting crops more water can be taken up and more water can be applied, less frequently. Young plants have shallow roots compared to fully grown plants. Thus, just after planting or sowing, the crop needs smaller and more frequent water applications than when it is fully developed.

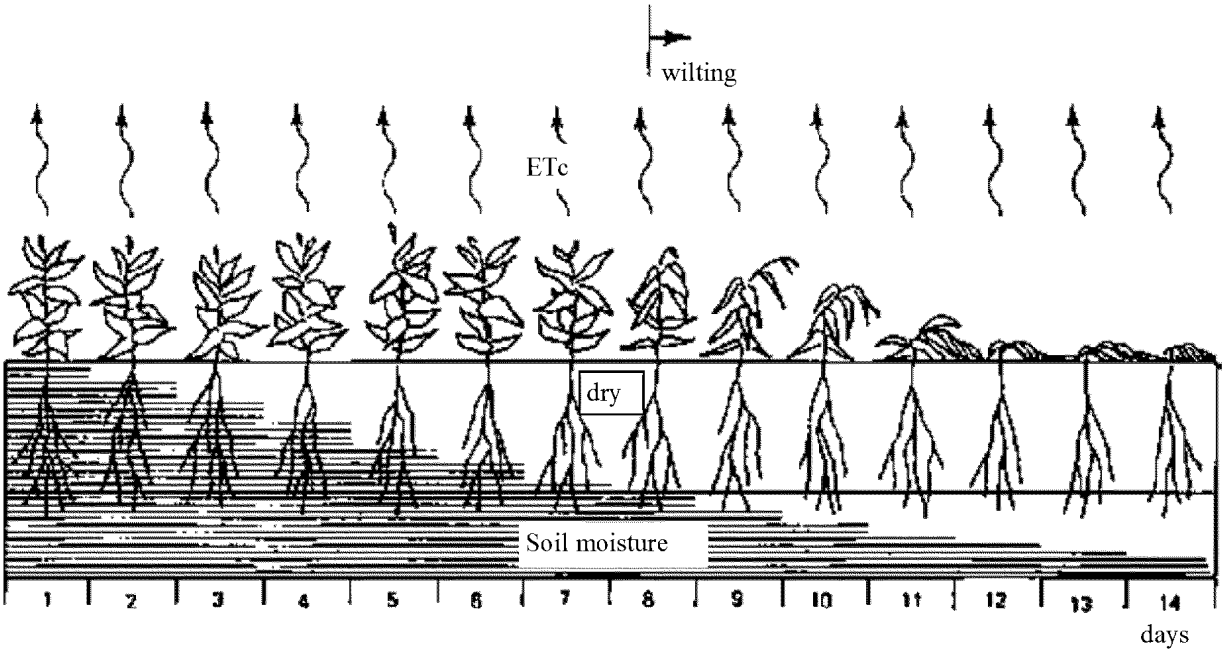


Figure 5-7 with no rainfall and no irrigation
Source: Irrigation Water Management Training Manual No.4 "Irrigation Scheduling". FAO, 1989

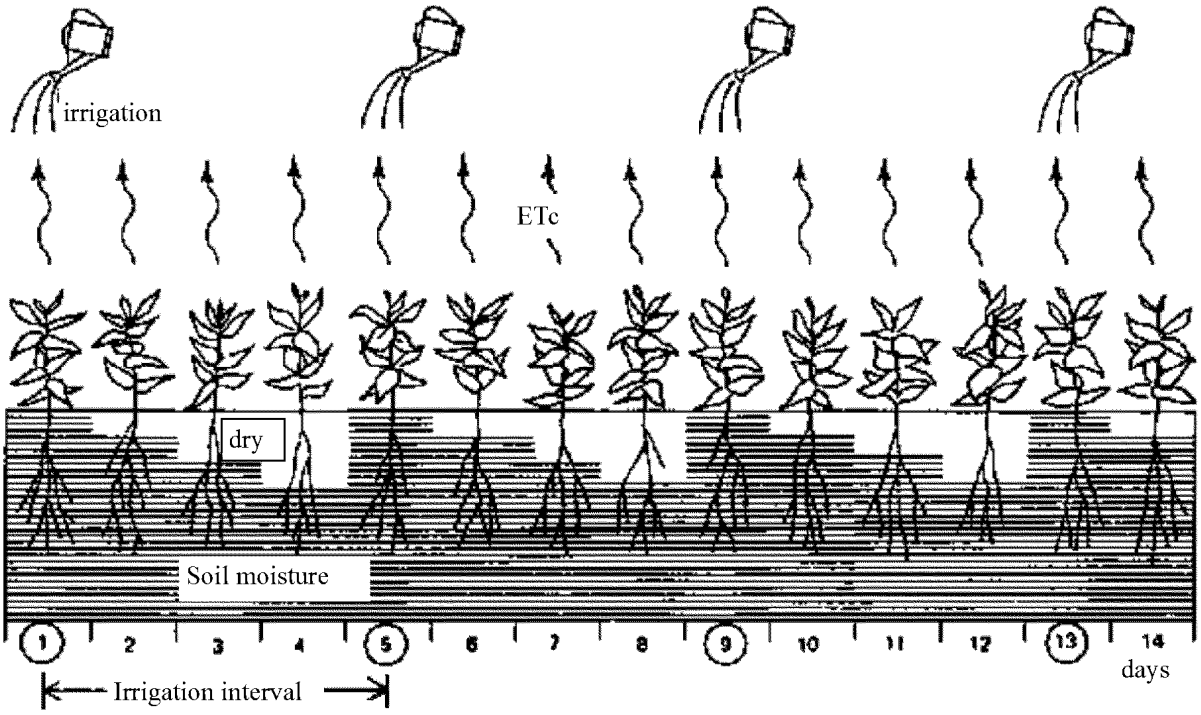


Figure 5-8 with irrigation

Source: Irrigation Water Management Training Manual No.4 "Irrigation Scheduling". FAO, 1989

The accurate determination of an irrigation schedule is a time-consuming and complicated process. The introduction of computer programs, however, has made it easier and it is possible to schedule the irrigation water supply exactly according to the water needs of the crops. Ideally, at the beginning of the growing season, the amount of water given per irrigation application, also called the irrigation depth, is small and given frequently. This is due to the low evapotranspiration of the young plants and their shallow root depth. During the mid season, the irrigation depth should be larger and given less frequently due to high evapotranspiration and maximum root depth. Thus, ideally, the irrigation depth and/or the irrigation interval (or frequency) vary with the crop development.

When sprinkler and drip irrigation methods are used, it may be possible and practical to vary both the irrigation depth and interval during the growing season. With these methods it is just a matter of turning on the tap longer/shorter or less/more frequently.

When surface irrigation methods are used, however, it is not very practical to vary the irrigation depth and frequency too much. With, in particular, surface irrigation, variations in irrigation depth are only possible within limits. It is also very confusing for the farmers to change the schedule all the time.

Therefore, it is often sufficient to estimate or roughly calculate the irrigation schedule and to fix the most suitable depth and interval; in other words, to keep the irrigation depth and the interval constant over the growing season.

(2) Seasonal Variation of Crop Water Requirement and Available Water

Figure 5-9 shows an example of the peak irrigation requirement of each month at the intake. It varies from 0.18 lit/s to 105.92 lit/s. there is a lot of leeway of available water in May, June, July, October and November. If cropping pattern is planned efficiently, available water is utilized more efficiently. The peak irrigation requirement must be less than available water.

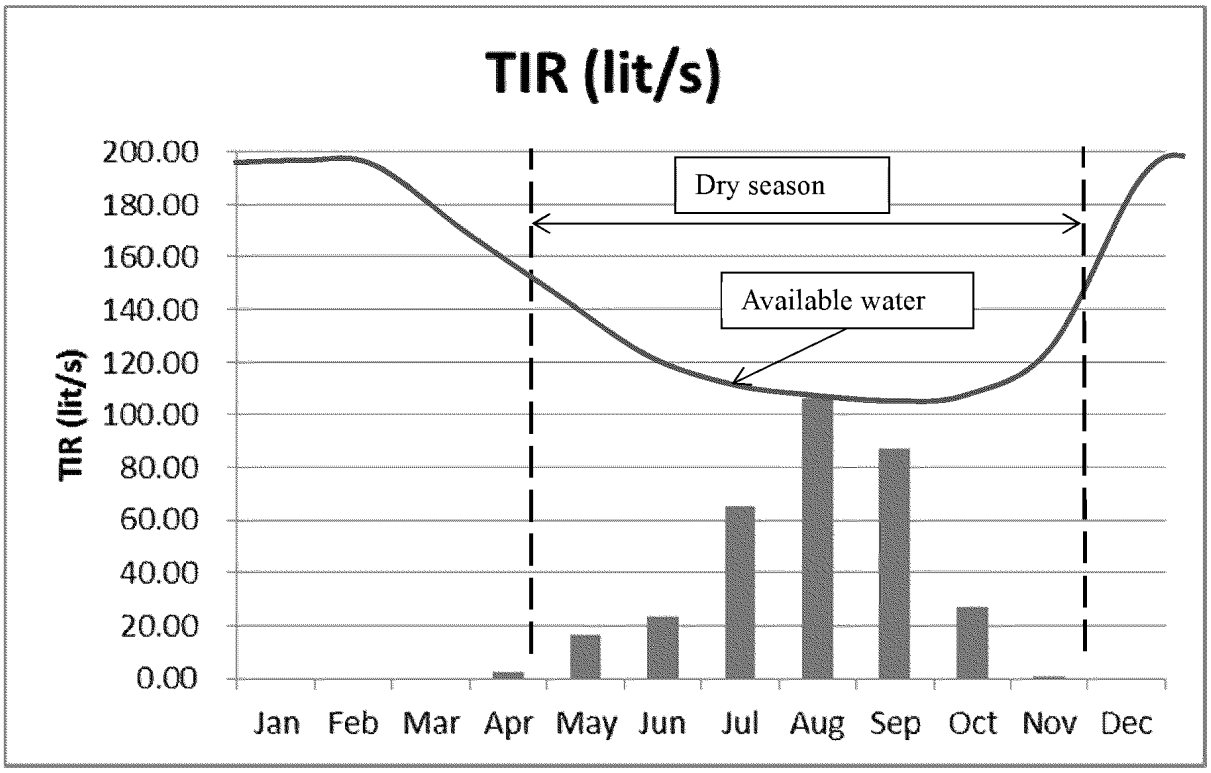


Figure 5-9 Monthly Total Irrigation Requirement (Scheme)
Source: T-COBSI Project Team

Table 5-9 shows example of irrigation requirement of typical crops.

In case of once/week, 8 hours irrigation, approximately 110 lit/s is required for 1ha. And it is enough for 5 has if rotation Monday to Friday each 1 ha or without rotation.

Table 5-9 Example Irrigation Requirement for Each Crop

Crop	Location	CIR	NIR	NIR(week)	Secondary Q.	Main Q	Secondary Q.	Main Q
frequency		daily	daily	1day/week	daily, 8hrs	daily, 8hrs	1day/week, 8hrs	1day/week, 8hrs
		mm/dec	mm/dec	mm/day	lit/s/ha	lit/s/ha	lit/s/ha	lit/s/ha
Maize	Mbala	92.00	153.33	97.58	4.84	16.13	33.88	112.93
Tomato	Mbala	86.10	143.50	91.32	4.53	15.10	31.71	105.69
Egg plant	Mbala	60.30	100.50	63.95	3.17	10.57	22.21	74.02
Rape	Mbala	68.00	113.33	72.12	3.58	11.92	25.04	83.47
Cabbage	Mbala	73.60	122.67	85.87	3.87	12.91	29.81	99.38
Okura	Mbala	72.90	121.50	85.05	3.84	12.78	29.53	98.44
Potato	Mansa	64.80	108.00	75.60	3.75	12.50	26.25	87.50
Onion	Mansa	81.90	136.50	95.55	4.74	15.80	33.18	110.59

Source: T-COBSI Project Team

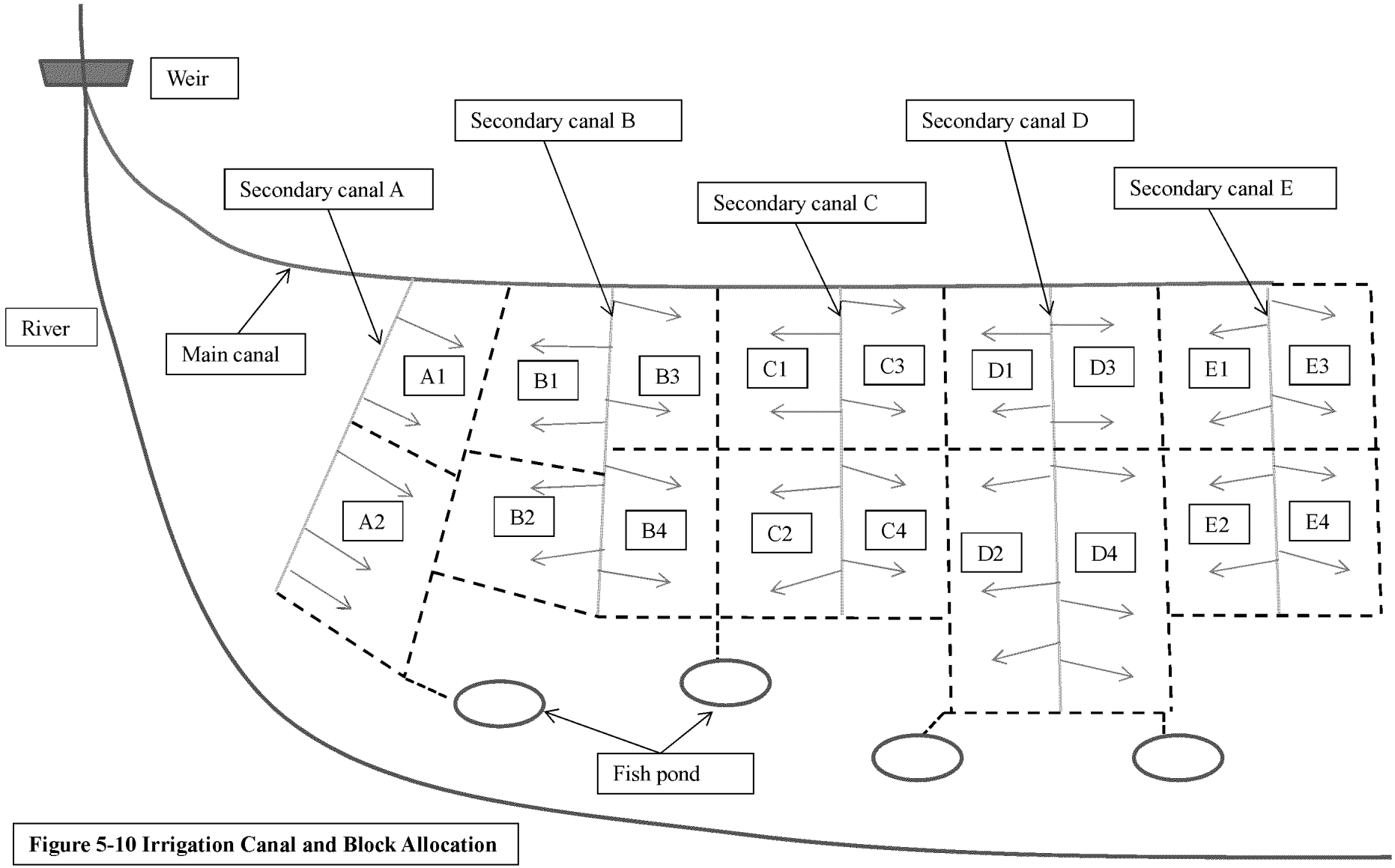
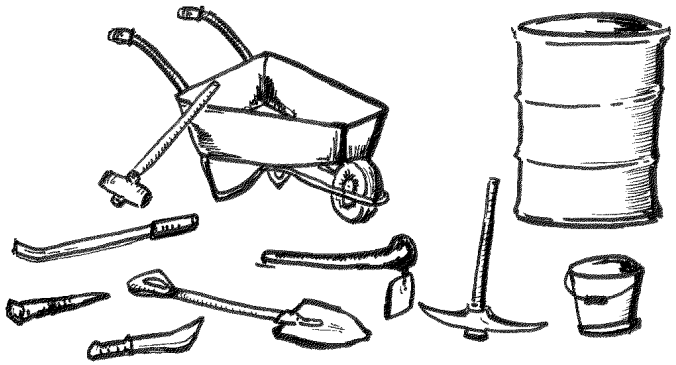
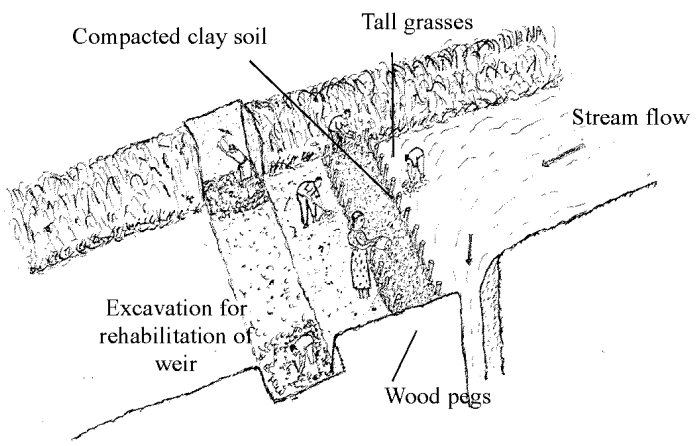
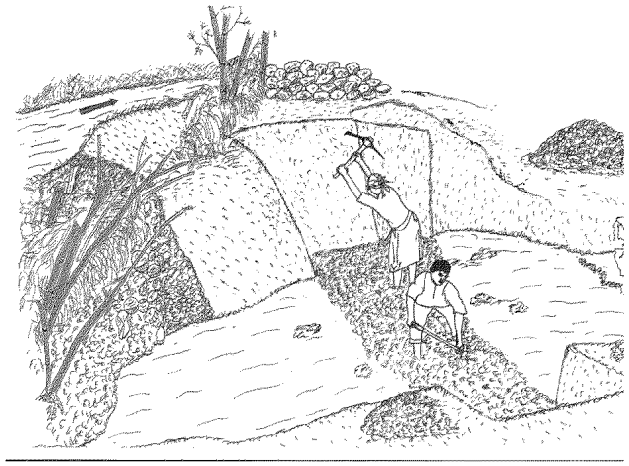


Figure 5-10 Irrigation Canal and Block Allocation

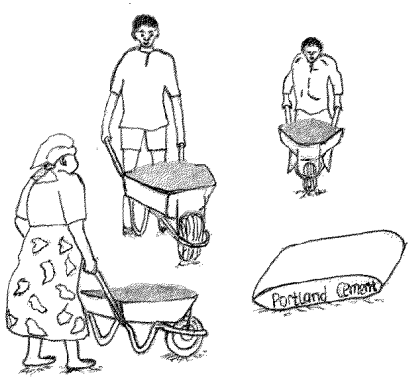
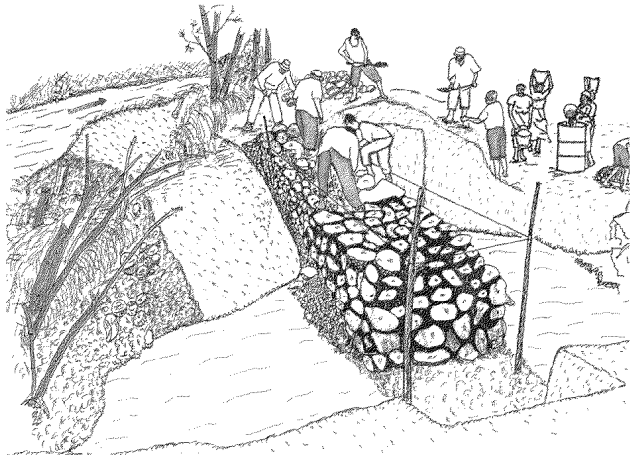
5.5 Construction

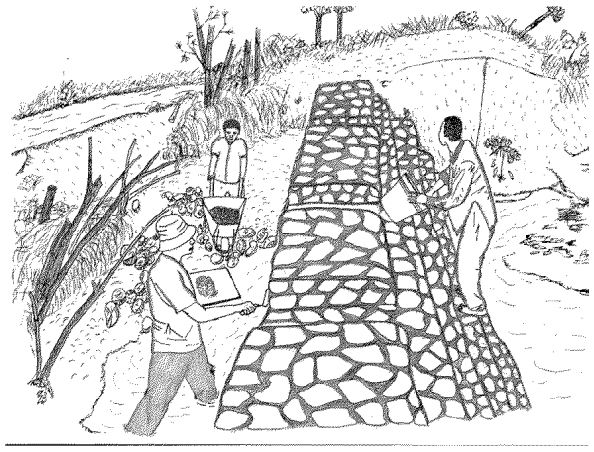
(1) Stone Masonry Weir

Step	Process	Description	Remarks
1		**Tools Required:** For the construction of permanent weir, the major tools required are: - Wheelbarrows - Hoes - Panga knives - Pickaxes - Chisels - Hammers - Buckets - Drum - Slashers - Shovels - Trowel	
2		**Tools Required;** For the construction of permanent weir, the major material required are: - Cement - Rubble stones - River sand	

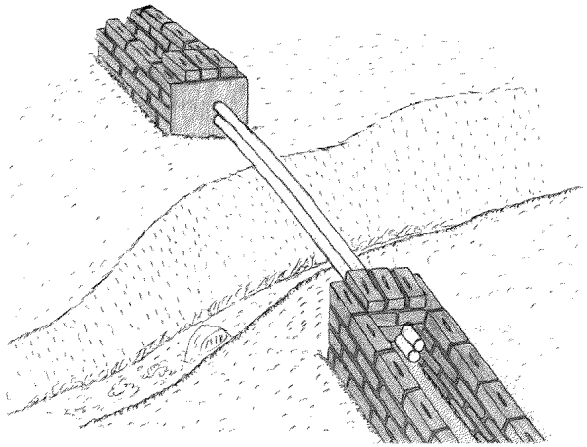
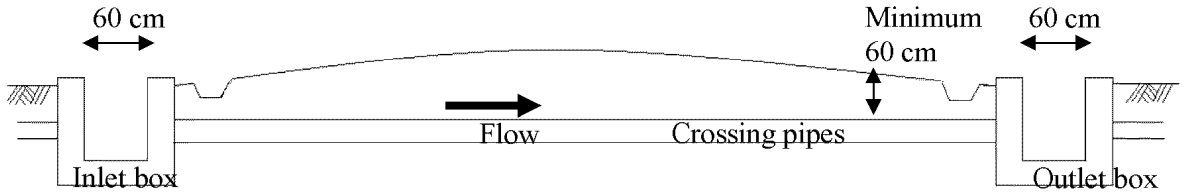
	Process	Description	Remark
2		<u>Cofferdam Construction</u> (a) Cofferdam with soils - Position wooden poles at the diversion point - Weave grass fence to tap the stream flow - Put clay soil on the grass fence - Compact the soil using logs (b) Cofferdam with sand bags - To fill sand bags with soils - To place sand bags tight each other at diversion point.	- Cofferdam is constructed to close the river (upstream of the construction site) so that the weir point is dry throughout the construction. - Rammers may be used for the compaction when available.
3		<u>Excavation for Weir</u> 1. The foundation is excavated to bedrock at least 50 cm depth from riverbed. 2. Abutment is excavated 1m horizontal direction into river bank. 3. The line of upstream end, downstream end and abutment shall be indicated with pegs and strings.	- If soft or unsuitable soil is found at the excavated depth, additional excavation shall be carried out. Precaution(>1.5m excavation) - Maximum safety against land sliding shall be ensured when excavating an abutment. - Elevation of cutting shall be checked.

5		<u>De-watering</u> 1. During the construction of the base, ensure that foundations are dry by dewatering using buckets.	- If there is a lot of ground water, dewatering shall be carried out continuously with buckets. Drain ditch and drain pit are required to be arranged. - Drainage pumps or treadle pumps may be used when buckets are not sufficient.
6		<u>Mortar Mixing Place Preparation</u> 1. Excavate a curved surface on a flat place (1.7m diameter). 2. Compact the surface with rammers or stones. 3. Lay bricks around the curved surface. 4. Place mortar in spaces between the bricks.	- The mixing place shall be as close to the construction place. - Compaction seals off all voids. - The Place can also be used for future rehabilitation.
		<u>Water for Mortar</u> 1. Prepare drum(s) of water for mortar at the site on the day of construction. 2. Water shall be clean water.	- Number of drums depends on the number of mortar mixing place.

7		<u>Stages of Mortar Mixing</u> 1. Standard mixing proportion of cement: sand is; ***1:3 in weight (dry)*** 2. Measure one 50kg bag of Cement and six buckets (20liter) of sand. If the sand is dry, 20 liter of water is poured and mixed first. Then additional water is sprayed and mixed to the proper consistency. 3. 1 bag of cement will be used with sand at the standard mortar mixing place at the same time.	
8		<u>Weir Construction</u> 1. Make sure that the closed river is dry, if not keep on dewatering. 2. Wash stones before used for construction. 3. Line the stones with the flat surface facing outside the structure (use a builders' level when constructing). 4. Mortar is pushed into the interstices and spaces between the stones. 5. Stones are placed layer by layer.	- Washing removes all debris thereby increasing the bond strength. - Voids shall be filled with mortar completely so that leakage may not happen and strength is secured. - Crest elevation and dimension shall be checked.

9		<u>Finishing and Curing</u> 1. The surface of stone masonry needs to be finished neatly and smoothly. 2. After completion of stone masonry, it needs to be covered with grasses or straw mats for curing mortar. 3. Water shall be sprayed from time to time.	

(2) Gully Crossing and Road Crossing

	Process	Description	Remark
1		<u>Gully Crossing</u> 1. A gully crossing is constructed to convey water across a gully. 2. The length of pipe is normally less than 6m. 3. The pipe is required to be installed at the height of 10cm from canal bed.	- Considering the strength of pipe and necessity of support, the length is less than 6m. - Since the length of pipe is limited, the location of gully crossing is decided considering the length.
2	<u>Road Crossing</u>  1. Pipes are installed under ground and soil covering depth shall be more than 60cm. 2. The pipes are installed at the height of 10cm from canal bed.		- Road crossing is constructed to convey water across the road.

5.6 O&M of Irrigation Facilities

5.6.1 Maintenance of Irrigation Facilities

(1) River Diversion Weir

As per fixed type weir of stone masonry or gabion, no routine maintenance work is usually required. Inspection around the weir should be carried out periodically and after every flood and every year before starting dry season irrigation. Following items should be inspected,

- Damaged part of stone masonry.
- Damaged part of slope protection.
- Scouring at downstream of the weir.
- Sediment at upstream.
- Scouring at both side abutments.

Damaged part of stone masonry should be repaired with mortar and damaged part of gabion should also be considered for rehabilitation. Scoured part at downstream of the weir should be protected by gabion or stone pitching. Scoured side abutment should be replaced with stone masonry or gabion, or reinforced with gabion or sand bags. In the case that sediment accumulated to inflow to canal, it should be removed. Maintenance check list is shown in the **Table 5-9.**

(2) Canals

1) Main and Secondary Canals

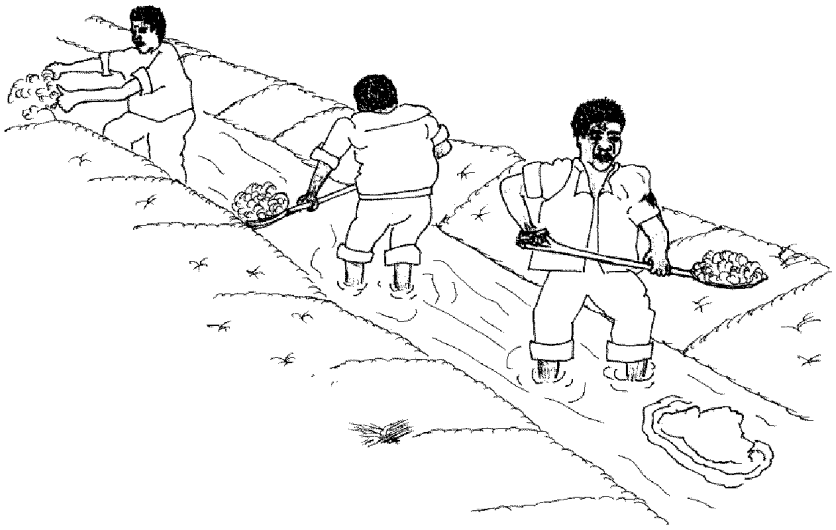
Stream water usually contains certain amount of suspended particulars, causing sedimentation in the canal. Eroded soil loss from field also gets into canal, resulting in the sedimentation in the canal. Maintenance work for canal should be done at least once before the irrigation season starts. Maintenance works required for the canal are; cleaning, weeding, de-silting, re-shaping, and also minor repairs as described below;

1) Earth canal

- Bushes and trees on the canal embankments should be removed. They may obstruct the water flow and their roots open the banks and develop leakages.
- Grasses, sediments and debris in the canal should be removed. While cleaning the canal, care must be so taken that the original shape of the cross-sections is kept. For this, a wooden frame with exact dimensions of the designed cross-section can be of great help.
- Crossing sections by people and animals (livestock) along the canal should be strengthened by hard compaction or lined with stones, bricks or masonry.
- Holes/cracks in the canal should be filled with sticky clay soil, and eroded sections should be rebuilt to the original shape.

2) Brick lined canal

- Grasses, sediments and debris in the canal should be removed.
- Cracks and water leaking point should be repaired with mortar.



2) Division Box, Discharge Box and Turnout

Division box, discharge box and turnout are made of brick masonry and the same maintenance work as brick masonry canal is required. In addition, maintenance on stop-log grooves is required. Damaged stop-log grooves should be repaired and reshaped with mortar to meet to stop-log. In case the connection part to earth canal is scoured, the part should be reinforced with gravel laying. Maintenance check list is shown in the **Table 5-10.**

(3) Maintenance Cost

Maintenance cost for each item is estimated as shown in **Table 5-11**.

Table 5-10 Maintenance Check Lists

Maintenance Check List for River Diversion Weir

Item	Frequency	Point to be checked	Findings
1. River	Daily	Water level	Elevation, Enough or not.
conditions	Daily	Water flow conditions	Stable or not. Flood, Rich or Drought.
	Daily	Sediment	If it is a lot to affect intake, it shall be removed.
		Others	Water quality, flotage etc.
2. Weir	Annually	Crack or damage of stone masonry	Small scale or large scale. Need repair or not
	At after	Erosion at abutment	Need repair or protection or not
	Annually	Water leakage	Small scale or large scale. Need repair or not
	Annually	Riverbed scouring at downstream	Need protection or not
	Daily	Sediment	If it is a lot to affect intake, it shall be removed.
	Annually	Damage of gabion	Small scale or large scale. Need repair or not
	Annually	Subsidence and deformation of gabion	Stable or not. Need repair or not.
		Others	
3. Intake	Annually	Crack or damage of stone masonry	Small scale or large scale. Need repair or not
	Daily	Sediment	If it is a lot to affect intake pipes, it shall be removed.
	Daily	Trash	If it is a lot to block intake pipes, it shall be removed
	Daily	Water level	Enough or not
	Monthly	Damage of pipes	Need repair or not.
	Daily	Function	Functioning or not.
		Others	
4. Others	Monthly	Conditions of stop log	Need repair or not.
	Monthly	Conditions of gate	Need painting, reapir or not.
		Protection bund	Collapse or erosion. Need repair or not.

Maintenance Check List for Canal System

Item	Frequency	Point to be checked	Findings
1. Brick or	Daily	Water flow conditions	Smooth or not
concrete	Monthly	Crack or damage	Small scale or large scale. Need repair or not
lined canal	Annually	Conditions of drain ditch (along the main canal)	Functioning or not. Need excavation or not.
	Monthly	Sediment	Small scale or large scale. Need removal or not
	Monthly	Weeds	A lot or a few. Need clearing or not.
		Others	
2. Earth canal	Daily	Water flow condition	Smooth or not
	Monthly	Cross section area	Enough cross section or not
	Monthly	Erosion	Need repair or not
	Monthly	Weeds	Need clearing or not
		Others	
3. Road	Daily	Water flow conditions	Smooth or not
crossing and	Monthly	Sediment	Small scale or large scale. Need removal or not
gully crossing	Monthly	Crack or damage	Small scale or large scale. Need repair or not
	Daily	Trash	If it is a lot to block pipe, it shall be removed
		Others	
4. Structures	Daily	Water flow conditions	Smooth or not
(division box,	Monthly	Sediment	Small scale or large scale. Need removal or not
drop box	Monthly	Crack or damage	Small scale or large scale. Need repair or not
turnout)	Monthly	Conditions of stop log	Need repair or not
		Others	
5. Others			

Source: T-COBSI Project Team

Table 5-11 Maintenance Cost for Each System

		Maintenance Cost Estimation						
	No.	Item	Specification/Quality	Quantity	Unit	Unit Price ZMK	Price ZMK	Remarks
	1	**River Diversion Weir**						
	1-1	Annual maintenance						
	(1)	Removal of sediment	unskilled labor	10.0	man		0.0	2man x 5 days
		Total		10.0	man		0.0	
	1-2	Every 5 years						
	(1)	Repair of stone masonry	weir, intake	1.00	m^3			
		rubble stone		0.54	m^3		0.0	
		sand		0.40	m^3		0.0	
		cement	ordinary portland	4.50	bags		0.0	
		material total					0.0	
		mortar mixing	unskilled labor	6.0	man		0.0	1day
		stone masonry	foreman	1.0	man		0.0	1day
			skilled labor	1.0	man		0.0	1day
			unskilled labor	5.0	man		0.0	1day
		labor total					0.0	
	2	**Open Canal System**						
	2-1	Annual maintenance						
	(1)	Cleaning canal	300m					
		unskilled labor		20.0	man		0.0	
	(2)	Repair of earth canal						
		Re-shaping	unskilled labor				0.0	each plot owner
	2-2	Every 3 years						
	(1)	Repair of brick lining						
		equivalent to 10m construction		10.0	m			
		Bricks		608.5	pcs		0.0	730.2x10/12
		Sand		0.2	m^3		0.0	0.34x10/12x0.5
		Cement	ordinary portland	2.6	bag		0.0	0.34x10/12x9
		material total					0.0	
		mortar mixing	unskilled labor	4.0	man		0.0	

		brick laying	skilled labor	1.0	man		0.0	
			unskilled labor	7.5	man		0.0	
		labor total					0.0	
	(2)	Repair of structures						
		equivalent to 1 box construction		1.0	box			
		bricks		223.0	pcs		0.0	223.0x1
		sand		0.1	m^3		0.0	0.15x0.8x1
		cement		1.4	bag		0.0	0.15x1x9
		material total					0.0	
		mortar mixing	unskilled labor	4.0	man		0.0	
		brick laying	foreman	0.3	man		0.0	0.33x1
			skilled labor	0.3	man		0.0	0.33x1
			unskilled labor	0.7	man		0.0	0.67x1
		labor total					0.0	
		Every 3 years Total	material				0.0	
			labor				0.0	

Source: T-COBSI Project Team

THE REPUBLIC OF ZAMBIA

MINISTRY OF AGRICULTURE AND LIVESTOCK

EXTENSION OFFICERS' MANUAL

(Prepared by RESCAP)

Ver. 2014

01_Sunhemp as Green Manure for NERICA

02_Tithonia as Green Manure for Vegetable Production

03_Tehprosia in Pest Control

For the T-COBSI Kick-off Training

MAY 2015

THE REPUBLIC OF ZAMBIA

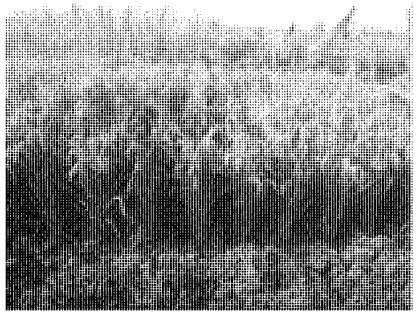
MINISTRY OF AGRICULTURE AND LIVESTOCK

EXTENSION OFFICERS MANUAL

ON

SUNHEMP USE AS GREEN MANURE FOR

NERICA IN DAMBO



MAY, 2014

This paper is about the use of sunhemp as a green manure for rice production in dambo. Green manures are grown so that the biomass (organic matter) in the crop can be transferred back into the soil.

1. What is sunhemp

- Sun hemp is a short-day, erect shrubby annual plant, generally 1 to 4 m in height. Its cylindrical and ribbed stems grow up to 2 cm in diameter. Its leaves simple and spirally arranged along the stem.
- This leguminous plant is extensively cultivated for fibre or green manure and leaves are fed as a high protein supplement to livestock (Chee and Chen,1992).
- Sun hemp is fast growing. Seedlings emerge 3 days after sowing, and rapidly produce a thick ground cover that suppresses weeds.

2. What are the benefits of using sunhemp

Sunhem produces abundant and succulent shoots (foliages); well adapted to local condition; having a high rate of nitrogen fixation; having high water-use efficiency when used in drier regions; while still producing substantial quantities of top-growth; fixes nitrogen in the soil.

1.1. Greater soil fertility

- Sun hemp recycles and add organic matter to the soil. It helps to prevent nutrients from being washed out of the soil the nutrients are taken up by the sunhemp and held inside the plant.
- When the nutrients are needed for the crop, the sunhemp is incorporated into the soil at booting stage or used as mulch on top of the soil. This helps increase crop yields.
- Legumes such as sunhemp and other nitrogen fixing plants which take nitrogen from the air to the soil are particularly beneficial.

1.2. Improved soil structure

- Sunhemp improves soil structure, letting more air into the soil and improving drainage.
- Sunhemp helps sandy soil hold more water and not drain so quickly.

1.3. Prevention of soil erosion

- Sunhemp helps to stop the soil being carried away by wind and rain. The roots penetrate the soil and hold it in place while the leaves break the raindrop impacts on the soil surface by providing the much needed cover.

1.4. Other benefits

- Weed suppression – Striga
- Livestock forage – Cattle, Chicken
- Pest control - Nematode
- Soil erosion control
- Unlike other legumes, sunhemp performs well on poor and acidic soils
- Feed to fish and other livestock.

1.5. Average Nerica yield from five selected sites in Luwingu District

The average yield per 5 by 5m plot from five sites in Luwingu District was collected, weighed and the results converted to kg/ ha and results are presented in a table below.

Treatment	Grain yield(kg)	Yield/ ha
Fundikila+ half rate basal+half top dress+ sunhemp	5.54	2,216
Fundikila+ full basal+ full top dress	3.85	1,540
Fundikila+ no basal+ no top dress	1.9	760

From the above table, it is clear that sunhemp supplemented the much needed nutrients to the crop as the yield in sunhemp fertilized fields had about 2tons/ha in terms of the Nerica yield compared to the average yield in field which followed recommended agronomical practices whose yield was 1.5 tons.

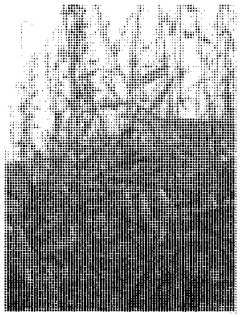
2. Types of sunhemp

Three types of Sunhemp are recommended as;

Crotalaria Juncea (Black)

Crotalaria Zanzibarica (Red)

Crotalaria Ochroleauca (White).



Black sunhemp is ideal for Region I & II. It does not do well in acid soils found in Region III. However, red and white types are good for Region III because they are acid tolerant.

Burying in or incorporation should be done at booting stage. Green manure crops are directly ploughed into the soil about 2-

3 weeks before the main crop. To get maximum benefit from green manure crops, it is important to plough them in before they begin to flower or at booting stage. In the case of trees, the leaves and tender branches are cut and then ploughed into the soil. Green manuring is an easy method of improving soil structure and fertility. Since the crop is grown right there where it is utilized, it makes the costs minimal.

1. General conditions

1.1. Climatic conditions

Sun hemp is drought resistant and is adapted to hot, semi-arid and arid areas, yet can tolerate light frosts. It is not tolerant of salt, nor of sustained water -logging. It is photoperiod-sensitive and flowering occurs in response to short days; long day lengths favour vegetative growth and reduce seed-set, although day length neutral selections exist. The seed rate is 5kg/ lima when broadcasted and 2.5 – 3kg/ lima when planted in lines.

1.2. Soil conditions

Sun hemp has a wide range of adaptation to soil types. It grows on poor soils, but growth on such soils is improved by fertilization. For fibre production, light, loamy, well-drained soils are preferred; on low-lying clay soils it makes vigorous growth, but then the fibre is coarser and yields are lower.

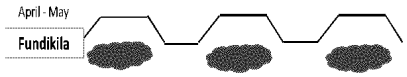
2. NERICA production in dambo using sunhemp as a green manure

2.1. Preconditions to apply this method

- Where irrigation water can be brought and drained through canals because sunhemp is sown during dry season.
- Avoid water logging condition because sunhemp does not grow well.
- Where soils are goods with much organic matter for NERICA production.

2.2. Site Selection, Land Demarcation and Fundikila

- Select a suitable area with relatively good soils, free from natural barriers, and with minimum undulations;
- Demarcate or measure the piece of land earmarked for the pilot using a field measuring tape and a rope and mark accordingly using pegs;
- Divide the plot into two subplots as shown on the Field Layout Plan.
- Grasses are buried underground as ordinal fundikila for both plots.



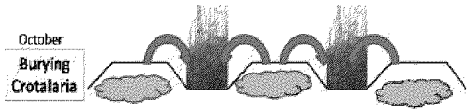
2.3. Planting of sunhemp

- Site selection is important because sunhemp is grown in Dambo using residual moisture or furrow irrigation.
- Sunhemp is planted in rows or broad casted and grown in the field in August.

2.4. Land Preparation

- Dig the land thoroughly using hoes to loosen up the hard pan for proper penetration of roots of the rice crop.
- Biomass of sunhemp grown is incorporated into the soil while preparing land for rice planting.

- Level the field smoothly using hoes so as to obtain a seed bed of fine tilth to facilitate even germination of seeds.



2.5. Basal-dressing Fertilizer Application and Planting

- Apply D Compound fertilizer in the given quantities in Plots.
- Drill the rice seed sparsely in the given quantities into furrows made 30 cm apart in Plots and bury accordingly.

2.6. Weeding and Top-dressing Fertilizer Application

- Weed in fields two (02) weeks after emergence when the crop is at seedling stage.
- Weed in fields again six (06) or eight (08 weeks after emergence when the crop is at tillering or booting stage.
- Apply Urea fertilizer in the given quantities by broadcasting evenly and incorporate into the soil.

2.7. Harvesting & Post-harvest Crop Handling

- Harvest the crop using sickles when 90% of the panicles turn golden yellow.

Nerica field ready for harvesting.

- Dry the harvested crop for three (03) days under shade for drying before threshing.
- Thresh the crop by beating the panicles against a hard surface using a stick, taking care not to break the grains in the process.
- Winnow the grain so as to get rid of chaff and other foreign materials such as soil, stones, etc.
- Spread the grain on a mat or concrete floor for 2 – 3 days for further drying before packing and storage.

2.8. Packing & Storage

- Bulk and pack in appropriate packaging materials.
- Store the grain in well-ventilated storage houses under lock and key.
- Take care of rain water, rodents, termites and other storage pests by regularly inspecting the stores and taking appropriate measures when need arises.

THE REPUBLIC OF ZAMBIA

MINISTRY OF AGRICULTURE AND LIVESTOCK

EXTENSION OFFICERS MANUAL ON TITHONIA AS GREEN MANURE FOR VEGETABLE PRODUCTION

May 2014

1. BACKGROUND

1.1. What is Tithonia diversifolia?

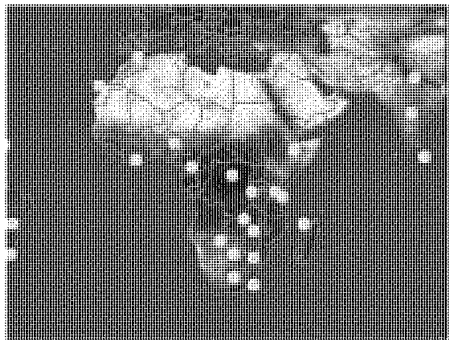
Common names in English are; Tree marigold, tithonia, Mexican sunflower. Tithonia is a quick growing and soft shrub. It grows to a height of 1-3 metres and bears alternately positioned leaves along most of the stem. The flower of tithonia is about 3 cm in diameter and has yellow petals. Each mature stem may bear several flowers at the top of the branches. The light weight seeds can easily be dispersed by wind, water and animals.

1.2. Ecology

Altitude: 550-1950 m, Mean annual temperature: 15-31 degree census, mean annual rainfall: 1000-2 000 mm. It is moderately resistant to drought.

Initially introduced into the region from Central America as an ornamental plant, it escaped from cultivation and now grows wild in hedges, along roadsides and on wasteland throughout the humid and sub-humid tropics at between 1000-2000 masl. T. diversifolia is a compositae shrub common on field boundaries in eastern Africa. The plant is now found as hedges in most of townships in Northern/ Muchinga Provinces in Zambia.

Distribution of Tithonia diversifolia in Africa



(Source: http://www.discoverlife.org/mp/20q?search=Tithonia+diversifolia)

2. MANY USES:

2.1. Soil improver

The plant has a high content of nitrogen and phosphorus from the soil, and decomposes quickly after application to the soil: its nutrients are released in about two weeks, making it available for crops. Crops such as maize respond well when leaves and cuttings are applied at the rate of 1 t/ha, but best results are obtained with 5 t/ha of leafy dry matter. This is equivalent to about 159 kg N, 15 kg P, 161 kg K, 100 kg Ca and 15 kg Mn per hectare.

<Chemical characteristics of Tithonia from Northern Province in Zambia>

Nitrogen (N) 2.7%, Phosphorus (P) 0.14%, Potassium (K) 4.2%, Calcium (Ca) 0.98%, Magnesium (Mg) 0.32% (Source: Mutuo, *et al.*, 2000.)

2.2. Results of pilot demo on Tithonia application for cabbage

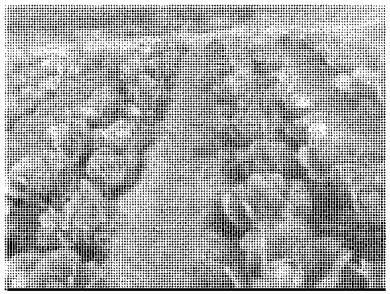
In Mporokoso, Officers conducted pilot demos in 2012/2013 and it was found that there was no difference in cabbage yield between a plot with (1) recommended rates of basal dressing + top dressing and (2) half rate of basal dressing + Tithonia top dressing twice.

It showed that results on Plot 2, recommended basal dressing combined with tithonia green manure top dressing, enabled to harvest 21 to 40 t per ha almost same level with Plot 1, recommended basal dressing and top dressing.

Yield results on Tithonia application to cabbage in Mporokoso District

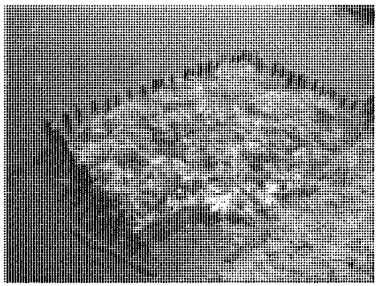
District	Camp	Plot 1				Plot 2				Plot 3			
		Weight/ head (kg)	Weight (kg)	No. of heads	**Yield/ ha (kg)**	Weight/ head (kg)	Weight (kg)	No. of heads	**Yield/ ha (kg)**	Weight/ head (kg)	Weight (kg)	No. of heads	**Yield/ ha (kg)**
Mporokoso	Chishamamba		10	19	**20,000**		11	19	**21,000**				
Mporokoso	Kambobe	1.0	111	111	**44,444**	0.9	100	111	**40,000**	0.5	13	26	**5200**

Pilot demo sites in Mporokoso District



2.3. Other Uses

- A suitable species for fodder for cows and goats. The leaves, soft branches and even the plant's yellow flowers are eaten. T. diversifolia has a high nutritive-quality index.
- Tithonia can be applied into fish pond as compost material for fish ponds.



Compost making using Tithonia in fish pond

Tithonia fodder to goat

- Tithonia provides farmers with firewood.

- An infusion of leaves is used as a medicine for constipation, stomach pains, indigestion, sore throat and liver pains. The leaves should be ground into small pieces, mixed with water, and then drunk. (Source: http://www.worldagroforestry.org/treedb2/aftpdfs/tithonia_diversifolia.pdf)

- Water extracts from Tithonia can be used to control termites and insect pests. Leaf extracts of *Tithonia* have been reported to cause mortality of the adult Diamondback moth. (Source: Carino and Morallo-Rejesus. 1982; Grainge *et al.*, 1984).

- Tithonia is used for live fencing and boundary demarcation. Tithonia can be planted on contours as hedges for soil and water conservation.

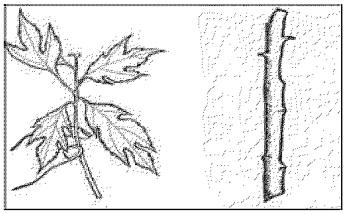
Tithonia hedge

3. PLANTING TITHONIA

Tithonia diversifolia can be applied as green manure to maize, sorghum, cowpeas, rape, tomatoes, beans and cabbage. For efficient use of labour, farmers can plant Tithonia in different niches on their farm by direct seeding or by using cuttings or bare-root seedlings. This will make Tithonia available within the farm. Tithonia can be cut back twice a year i.e. at the start of each season.

3.1. By using cuttings

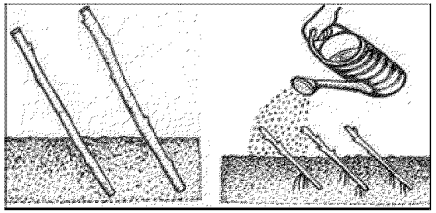
- To make cuttings, select a mature stem and cut a piece with 4 or 5 nodes of 20-30 cm long. Make sure they are cut cleanly as split pieces do not root.



- Put the cuttings in the ground at an angle of 45_o - 60_o, with about two nodes above the ground and about two below the soil.

- Water the cuttings after planting.

- The cuttings root from the nodes below ground and establish as strong plants.

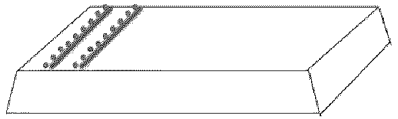


3.2. By sowing seeds

- You can easily propagate Tithonia by direct seeding.

- The best method is to make a furrow for the seeds and cover them lightly with sandy soil.

- Then apply mulch to prevent the seeds from being washed away and to retain the soil moisture.



4. HOW TO APPLY TITHONIA AS GREEN MANURE

4.1. Which part of Tithonia can I use?

- Younger leaves and twigs of Tithonia are easier to dig into the soil than older ones.
- If plants become too old and tough, they will be more difficult to dig in. Soil organisms will find it difficult to break down and decompose old, tough plants. It is better to avoid old or tough stems too because they may take roots in the soils and turn to weeds.

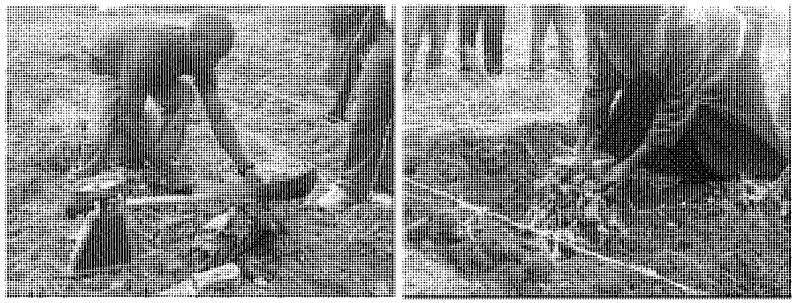
Only younger leaves and twigs are collected by Panga knife

4.2. What stage of Tithonia is the best time to dig in?

- The best time to dig in is just before flowering begins because that is when concentration of nitrogen and phosphorus in Tithonia become high.

4.3. How can I apply it?

- To apply tithonia, cut leaves and soft twigs of tithonia from the hedges, chop them into small pieces, and either place them in each planting hole or spread them evenly over the surface and then incorporate them into the soil.



- After you apply the leaves, they must be mixed well with the soil or left to decompose for at least 1 week before you plant. The maize and other crops may not germinate well if they are planted immediately because of heat generation during the decomposition process of the leaves (which could damage the seeds).

4.4. How often can I apply?

- You can continue applying this green manure throughout the active growing period of the crop either by placing it along the rows of plants or by incorporating it into the soil.

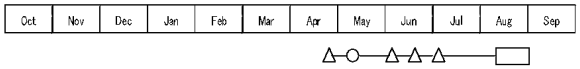
4.5. For what kind of crops can I apply it?

- Tithonia diversifolia can be applied as green manure to maize, sorghum, cowpeas, kale, tomatoes, beans, cabbage as well as to high-value crops such as French beans and pineapples.

4.6. In which season can I apply Tithonia?

- It can be applied to crop in rainy season for rain-fed crops or vegetables in dry season. But dry season is ideal season for vegetable production.

Cropping pattern for cabbage

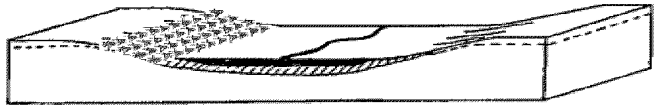


Key: Sowing:○ Tithonia application:△

4.7. What kind of land is suitable for this technology?

- Tithonia green leaves is bulky and transportation of the green leaves to the field is difficult if there is a distance from Tithonia hedges and the field.
- It is ideal to apply Tithonia during dry season for vegetables because it is commonly naturalized in dambo areas, where farmers grow vegetables so there is no transportation problem. The concentration of nitrogen and phosphorus in the leaves is high at the beginning of dry season.

Cross section of Dambo



4.8. Does it fix nitrogen like legumes?

- Tithonia is not a legume so it does not fix nitrogen. Where Tithonia is grown and used on-farm, the use of Tithonia cycles nutrients within the farm but does not supply a net input of

nutrients to the farm. So farmers can be encouraged to use a combination of Tithonia with inorganic sources of phosphate or other organic sources such as animal manure.

4.9. What about labour requirement?

- It is also important that green manure transfer has greatest potential when (a) the costs of labor are low, (b) when the value of the crop is high.

4.10. What kind of management is required for Tithonia hedges

- Tithonia hedgerows have to be cut back regularly; otherwise it can spread fast and become a weed.

4.11. Can I inter-plant Tithonia with crops?

- Inter-planting Tithonia with other crops in the field is not recommended due to root competition with crops.

5. APPLICATION IN CABBAGE PRODUCTION

5.1. Site selection (areas with furrow or residual moisture)

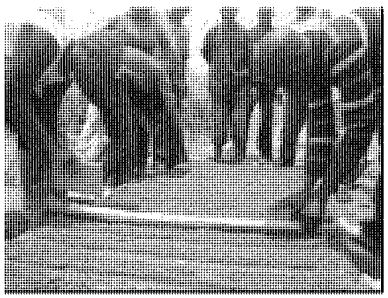
Farmers can select sites for Tithonia application as follows;

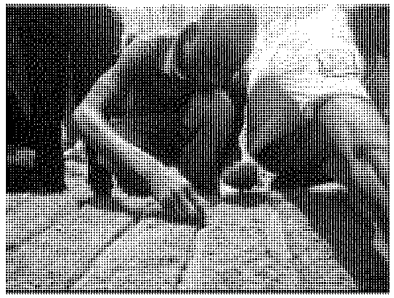
- Areas where farmers grow vegetables with adequate water source,
- Areas where Tithonia has already naturalized in the areas,
- Home yard gardens where there are Tithonia hedges are already established.

5.2. Nursery making & sowing seed (1m x 2m bed)

- Seedbed Preparation - Dig soil deeply and break large clods. Weeds should be removed.
- Seedbed should be raised to 20~25cm high.
- Sterilization of bed - Put water to the soil then place enough straws on the bed and burn them.

- After sterilization, apply 3-5kg of well decomposed manure per m^2 and mix it with soil thoroughly.
- One-by-one sowing method to raise strong seedlings. Thick sowing makes seedlings spindly and it is not economic.





5.3. Land demarcation/ preparation and furrow clearing

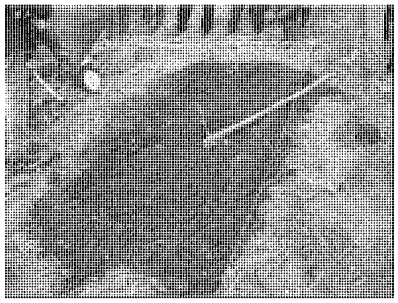
- Demarcate or measure the piece of land earmarked cabbage growing using a field measuring tape and a rope and mark accordingly using pegs.
- Clear the demarcated plot to free it from thickets, trees, shrubs, tall grass, etc that would make cultivation difficult.

5.4. Bed making & Tithonia application (a week before transplanting)

- The treatment supplies the crop with nutrients at the early stage of the growing process, and thus improves the establishment of the crops through the early development of a good rooting system.

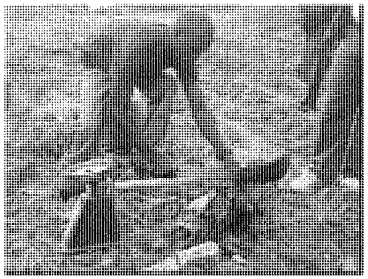
Digging – Dig the land thoroughly using hoes to loosen up the hard pan for proper penetration of roots of the crop.

Bed making – Make sunken beds using hoes so as to retain moisture.



Tithonia collection – (1) Cut Tithonia branches using panga knife (2) remove leaves from branches (3) put the leaves into 25kg empty bags (4) make 3 bags of 8 kg Tithonia (25kg is required for 5m x 5m plot).

Tithonia application – (1) make ditches with depth of 20cm and width of 20cm on the beds using hoe (2) chop leaves and soft twigs into small pieces (3) bury Tithonia leaves in the ditches as band application.




5.5. Transplanting & D-com application (30 days after sowing)

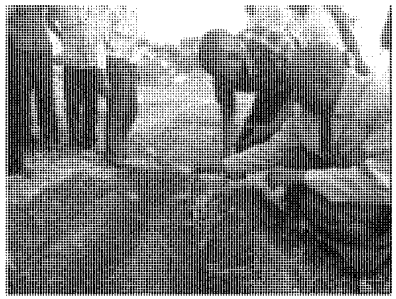
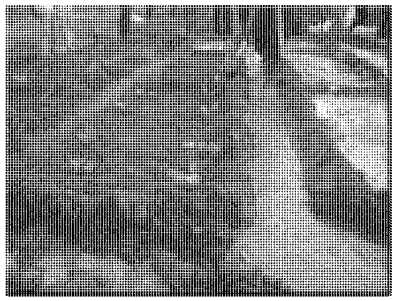
- Tithonia green manuring - before planting - and mulching can be combined, which is especially applicable to maize, beans and cabbage cultivation.

  Apply D Compound fertilizer half- rate of the recommendation per station (10g) followed by incorporation .

  Water the bed enough before 12 hours of transplanting.

  Transplant healthy seedlings of 10 to 15cm height with spacing of 45 to 60cm between the row and 45cm between the plants in the late afternoon or on a cloudy day to minimize the shock of transplanting.

  Tithonia leaves buried and plant roots should not have direct contact because heat generated from decomposition of Tithonia damage plant roots.

5.6. Insect control - Tephrosia spray (1kg/5L water)

- Crush Tephrosia leaves. It does not need to be done perfectly.
- Soak approximately 1 kilogram of crushed leaves in 5 liters of water.
- After soaking the leaves in water for two hours or boiling them for 30 minutes, filter the juice through a cloth and use directly in a sprayer.
- Add a bit of soap to help the spray stick to the plant.
- Warning: Tephrosia is dangerous to fish, humans, animals and wild life. Wash hands with soap as soon as you have finished using it. Do not use Tephrosia to poison fish.

5.7. Weeding and first top dressing (Tithonia) – 3 weeks after transplanting

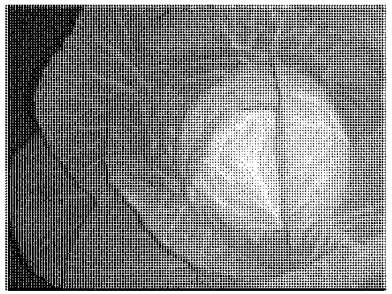
- Weed in all beds when necessary. Apply **two double handful** (400g) of chopped leaves and soft stems of Tithonia per station.

5.8. Weeding and second top dressing (Tithonia) - 7 weeks after transplanting

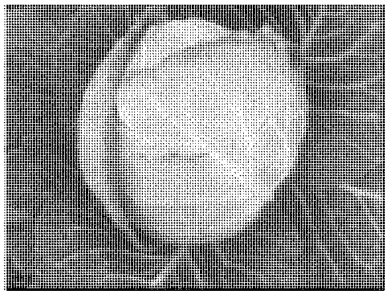
- Weed in all beds when necessary. Apply **two double handful** (400g) of chopped leaves and soft stems of Tithonia per station

5.9. Harvesting - 90 to 120 days after sowing (depending on the varieties)

- Harvest the heads using knife when cabbage heads become firm. Delay in harvesting causes bursting the heads.



Cabbage head ready for harvest



Cabbage head cracked due to late harvest

The yellow colour indicates flowers of Tithonia in Kasama in Northern Province, Zambia

6. Reference:

- 'Using the wild suntlower, Tithonia, in Kenya' (ICRAF 1997)
- World Agroforestry Centre – www.worldagroforestry.org
- Agroforestry Database 4.0 (Orwa et al.2009)

THE REPUBLIC OF ZAMBIA

MINISTRY OF AGRICULTURE AND LIVESTOCK

EXTENSION OFFICERS MANUAL

ON

USE OF *TEPHROSIA VOGELLI* AS A BOTANICAL PESTICIDE AND AN ACARICIDE IN PEST CONTROL FOR SMALL SCALE FARMERS

May 2014

1. Background

1.1. What is Tephrosia?

Tephrosia vogelii is native to tropical Africa, and is found growing naturally in widely varying habitats, including savannah-like vegetation, grassland, forest margins and shrub and, wasteland and fallow fields.

Scientific Name: *Tephrosia vogelii*

Bemba Name: Ububa

English Name: Fish bean

1.2. Where does Tephrosia grow?

…grows at altitudes between up to 2100m

…grows in areas with average annual temperature: 12 - 27 oC

…grows in areas with average annual rainfall: 850-2650 mm

…grows well on any soils not subject to flooding and on well drained loams with pII 5-6.5; is also tolerant to poor soils with low pH (acid soils), although can be prone to disease.

1.3. What is Tephrosia vogelii used for?

In Northern Province, Tephrosia is grown to improve soil fertility, as firewood, and as an insecticide against storage pests and mites on plants. Traditionally, it is used as a fish poison, although this is illegal in Zambia because of its indiscriminate killing of fish of all sizes.

Tephrosia leaves contains an active ingredient, a chemical called "rotenone" which is classified by the World Health Organization as a moderately hazardous or Class II pesticide.

1.4. Why Tephrosia is usefull?

The most important issues raised by all the District livestock officers in Northern Province were, high cost of veterinary medicine, lack of access to chemicals by farmers and long

distance time to procure drugs and low adoption of acaricide within villages. This has resulted in high infestation of tick borne diseases on cattle such as East coast fever.

During a monitoring workshop held in November 2010 in Kasama, extension officers came up with technical action plan against problem of the issue and they indicated, "Promotion of use of local medicines" as an important action to be implemented by themselves.

During a pilot exercise in 2011, small holder farmers who had no access or limited resources to purchase chemical acaricide used an extract of *Tephrosia vogelli* leaves as an acaricide in Luwingu and Mporokoso to control ticks on cattle and aphids in crops in Kasama and it was found to be very effective.

1.5. Disadvantages of using synthetic acaricide

There are a number of harmful effects that synthetic pesticides have on the environment, animals and humans.

- Chemical pesticides may kill useful insects which eats pests
- Synthetic chemicals can stay in the environment and in the bodies of crops and animals causing problems for many months and years respectively
- Insect pests can recover very quickly over a few breeding cycles and develop resistance to synthetic chemicals. This may result in increased amounts or stronger chemicals being used creating further economic, health and environmental problems

1.6. Advantages of using natural acaricide

Natural acaricide has some advantages.

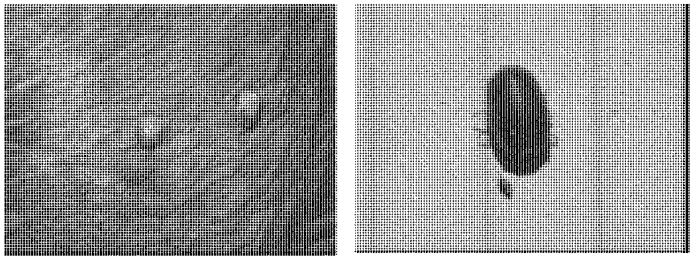
- It leaves no residues on crops and cattle because rotenone breaks down within 3-5 days after application.
- Acaricide does not kill most of the useful insects.
- Dosages do not create economic, health and environment problems.

2. How do you use *Tephrosia vogelii* as a pesticide?

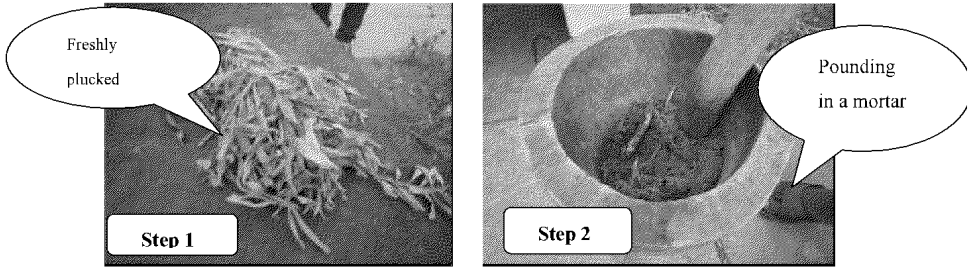
Freshly plucked Tephrosia leaves were collected from plants and pounded in a mortar. Approximately 1 kg of fresh leaves soaked in 5 liters of water overnight. (50 g of crushed paste of Tephrosia per 100ml of water). The extracted water was mixed with soap as a sticker. T.vogelli extracted water was sieved through a cloth and poured into a sprayer. Then the cattle were confined in the crush pen. Cattle were thoroughly sprayed with Tephrosia solution. Particularly, places where they were more ticks were intensively sprayed.

2.1. Protection of domestic animals

Ticks are known as vectors transmitting some critical diseases like East coast fever to animals and it is known that the active ingredient "rotenone" in *Tephrosia* is effectively control ticks. Therefore small holder farmers who have no access or limited resource to purchase chemical acaricide are advised to use *Tephrosia* leaves as acaricide.



2.2. How to prepare and spray T.Vogelli extract to control ticks on cattle



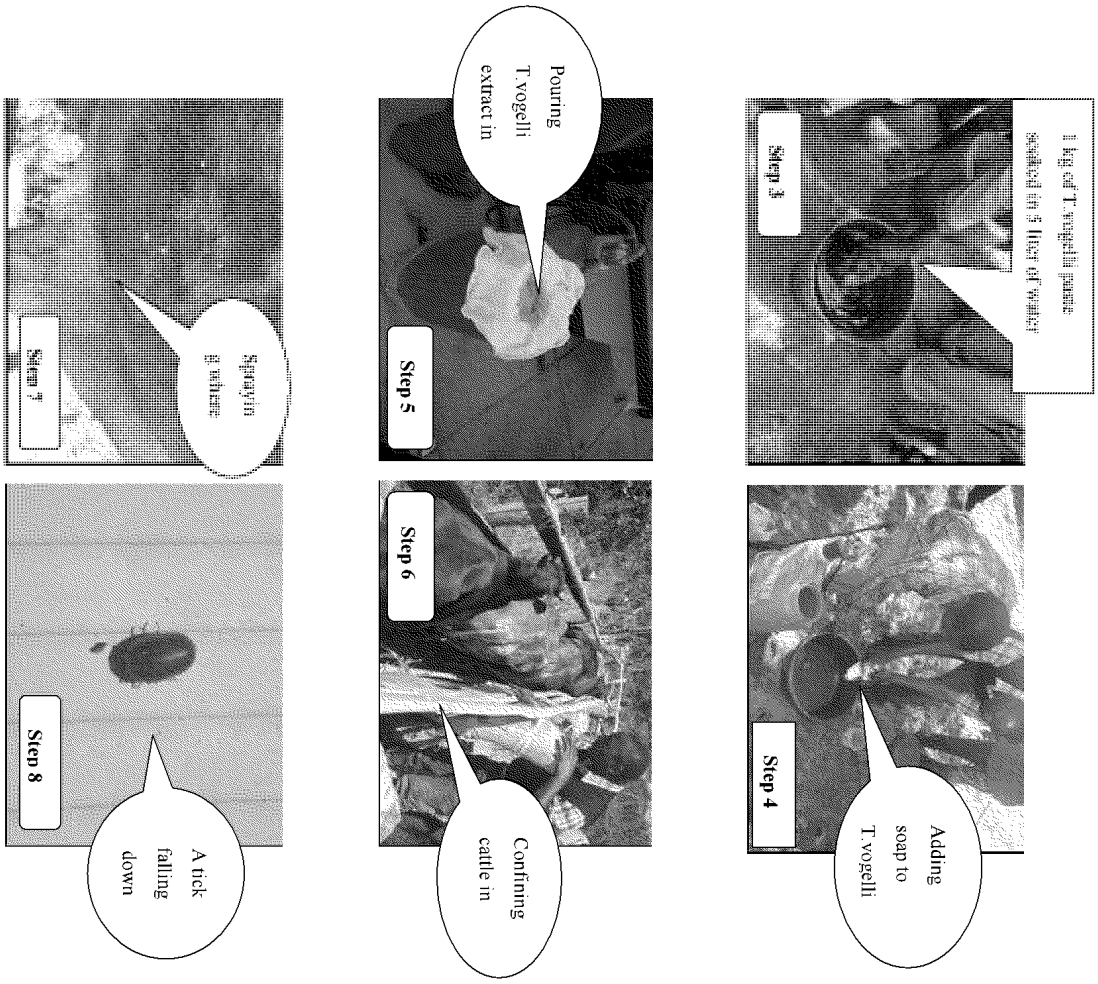


Table 1: Comparison between chemical acaricide and natural acaricide (Tephrosia extract)

Synthetic acaricide	Natural acaricide
Stay in the bodies of animals longer	Leaves no residues on cattle-rotenone breaks down within 3-5 days after application
Expensive	Cheap
Not easily accessible in villages	Raw materials easily accessible in villages
Dosages has a supposed to be followed	Simple to prepare and apply

Table 2: Type of Ticks treated by Synthetic Acaricide and Natural Acaricide (Tephrosia extract)

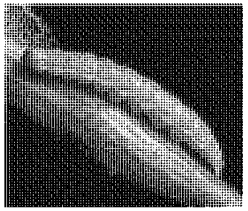
Disease/ condition	Vector	Symptoms	Synthetic Acaricide		Natural Acaricide	
			Treatment	Control	Treatment	Control
Theileriosis (East cost fever) in cattle	Ticks: (Brown ear tick)	High fever Swelling of superficial lymph nodes Difficult breathing	Parvexone Butalex (buparvaquone	Weekly dipping: Hand spraying	Tephrosia extract (Rotenone)	spraying
Anaplasmosis (gall sickness) in cattle	Ticks: Blue ticks	High fever Constipation Rumination ceases Laboured breathing	Ox tetracycline imizol	Weekly dipping: Hand spraying	Tephrosia extract (Rotenone)	spraying

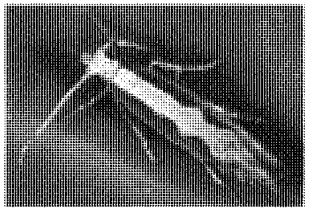
2.3. Control of field insects

Harvest leaves from the Tephrosia plants. When harvesting, only the leaves need to be taken off the shrub. If removed carefully, the shrub will continue to produce leaves for future use or for improving soil fertility.

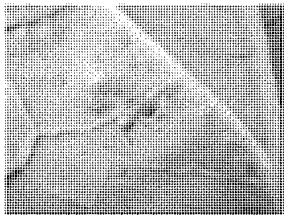
To extract the active ingredients, pound the fresh leaves in a mortar. The effective concentration is approximately one kilogram of leaves for every 5 litres of water. The crushing of leaves does not need to be done perfectly. After soaking the leaves in water for two hours or boiling them for 30 minutes, filter the juice through a cloth and use directly in a sprayer. Add a bit of soap to help the spray stick to the plant.

This mixture can be sprayed on garden vegetables, fruits, field crops and nursery seedlings for the control of different kinds of insect pests. It is important that the sprays have direct contact with the pests. If the pests are underneath the leaves, be sure to actually hit them. This treatment is effective up to seven days. After that time the process must be repeated. In areas of heavy termite infestation, the leaf mulch can also be very helpful.



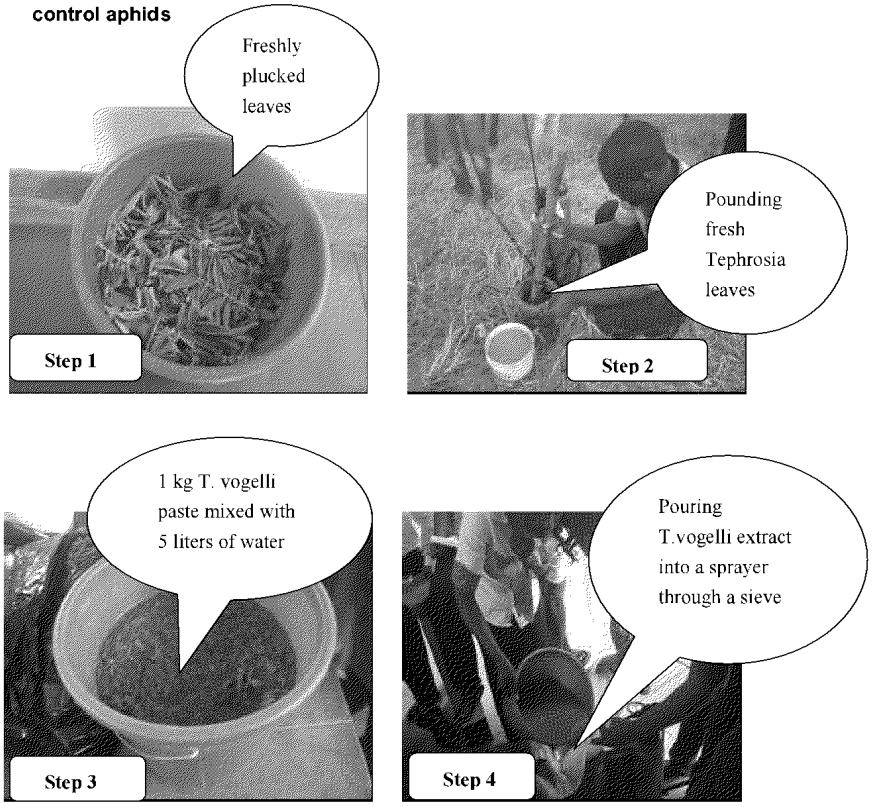


Diamond back moth



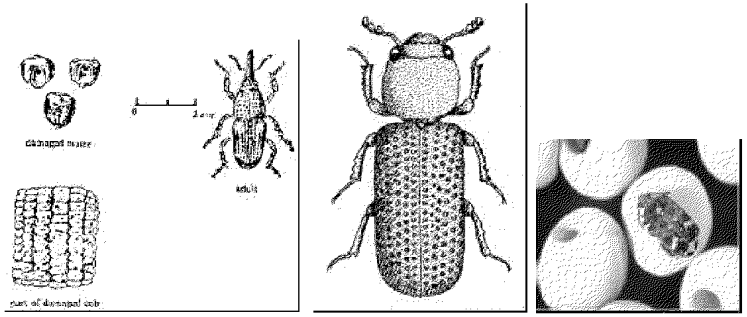
Aphids

2.4. How to prepare and spray T.Vogelli extract on vegetables and citrus to control aphids



2.5. Protection of stored grains

Tephrosia vogelii leaves may also be used for the protection of stored cereals and legumes. Take the fresh leaves and dry them under the sun. Grind or pound the dried leaves into a powder. Mixing 100 grams of powder with 100kg of maize or beans will protect the grains from weevils, the larger grain borer or bean bruchids. This treatment is effective up to three months. After that time the process must be repeated. Thoroughly wash the Tephrosia powder off grains before using the maize or beans for food.

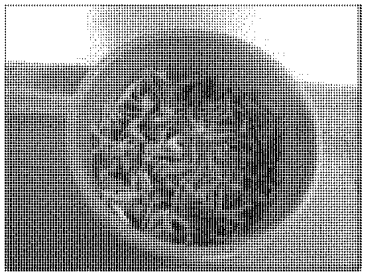


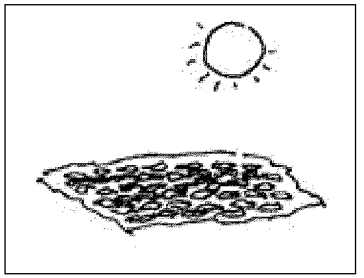
Weevils

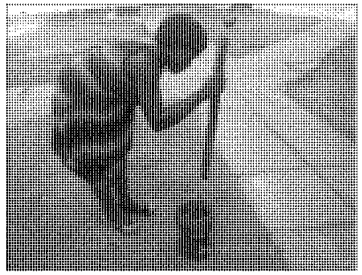
Grain borer

Bean bruchids

2.6. How to prepare it for stored grains







Mixing 100 grams of powder with 100kg of maize or beans

2.7. Safety Precautions and shelf life

Despite of the goodness on the Tephrosia natural acaricide /insecticide, it needs to be used carefully following safety precautions:

- Avoid direct contact with the skin and eyes.
- Use protective clothing and gloves
- Try to keep the extract away from your skin or use gloves if available.
- Poisonous to fish and aquatic life
- Rotenones are very toxic to pigs, so extreme care should be exercised if treating pigs.

3. Production of Tephrosia vogelli shrub

3.1. Where should I plant Tephrosia?

Soak seeds overnight before planting. You can plant Tephrosia in rows or stands. For a green-manure crop, the recommended spacing is 50cm x 50cm, with 2-3 seeds per hole; when planted for hedges the spacing should be 1.5m between the rows.

When sown in rows, the recommended sowing rate is 5 kg/ha and when broadcast 8-13 kg/ha. It is important that the site is not waterlogged, as Tephrosia does not do well on such sites.

Tephrosia seed multiplication in Mporokoso

3.2. When should I plant Tephrosia?

Tephrosia should be sown at the beginning or middle of the rainy season or at any time after maize planting until the middle of the rainy season to make sure it gets sufficient rains for establishment.

3.3. How many days does it take for Tephrosia to germinate?

Most seeds will have germinated 8-10 days after sowing. The germination percentage is 65%, and the seedling survival rate about 60%. Soaking in warm water (45° C) stimulates germination.

3.4. How can I ensure that my seedlings grow well after germination?

Tephrosia grows rather slowly. This means that there may be a problem with competition from weeds. The planting stations need to be weeded.

Note: Maize should be planted in rotation in the field after Tephrosia because it is not attacked by round worms.

Schedule of the Mid-Term Training (MTT) at Kasama Farm Institute
From August 10 to 13, 2015

DAY 0 (August 9, Sun): Gathering to the venue

DAY 1 (August 10, Mon): **(Mr. Sifaya)**

Module 1 - Program Orientation *(Mr. Sifaya)*

08:00-08:45 Registration and pre-training knowledge inventory
08:45-09:00 Welcome remarks and program orientation (housekeeping issues)
09:00-09:45 Opening (PACO/PAO), self-introduction,
09:45-10:15 Overview of the training
10:15-10:30 Health break

Module 2 –What's T-COBSI *(Mr. Sifaya)*

10:30-11:00 What's T-COBSI (especially for SAO and District Marketing Officer)

Module 3 –Introducing SHEP Approach and Action Plan of Northern Province *(Mr. Banda)*

11:00-12:00 Presentation
12:00-12:30 Questions and comments
12:30-13:30 Lunch

Module 4 – Presentation of the Project Progress *(Mr. Simukoko, Mr. Mbewe)*

13:30-15:30 Presentation by district
15:30-16:00 Lessons learned and challenges

Module 5 – Participatory Market Survey *(Mr. Chikampa)*

16:00-17:00 Introduction of market-oriented farm activity

DAY 2 (August 11, Tue): **(Mr. Sifaya)**

07:30-08:30 Registration and recapitulation

Module 5 – (Continued) Participatory Market Survey *(Mr. Chikampa)*

08:30-09:00 Preparation of the participatory market survey
09:00-11:00 Conduct of participatory market survey

Module 6– Formulating a Farm Plan based on Market Information *(Mr. Sifaya, Mr. Chikampa)*

11:00-12:00 Documentation of the market survey result
12:00-13:00 Lunch
13:00-15:00 Crop ranking and its selection
15:00-15:15 Health break
15:15-16:30 Preparation of cropping calendar
16:30-17:00 Verification of the farm plan

DAY 3 (August 12, Wed): **(Mr. Simukoko)**

07:30-08:30 Registration and recapitulation

Module 7 – Formulating an Action Plan to Carry out the Farm Plan *(Mr. Sifaya, Mr. Chikampa)*

08:30-09:30 Problem analysis
09:30-10:30 Objective analysis
10:30-10:45 Health break
10:45-12:00 Group action plan formulation
12:00-13:00 Lunch

Module 8 – Organization/ Gender Issues to be Considered for Agr. Development

(Ms. Marry, Mr. Mbewe)

13:00-15:00 Theory and exercise
15:00-15:15 Health break
15:15-17:00 Theory and exercise continued

DAY 4 (August 13, Thu): **(Mr. Sifaya)**

07:30-08:30 Registration and recapitulation

Module 8 – (Continued) Organization/ Gender Issues to be Considered for Agr. Development

(Ms. Marry, Mr. Mbewe)

08:30-10:00 Theory and exercise
10:00-10:15 Health break
10:15-12:00 Theory and exercise continued
12:00-13:00 Lunch
13:00-15:00 Theory and exercise continued

Module 9 – Program Evaluation and Closing *(Mr. Simukoko)*

15:00-15:30 Evaluation of the training program
15:30-15:45 Closing (PACO/PAO)

DAY 5 (August 14, Fri): Home Sweet Home

Have a Safe Trip!

T-COBSI

Technical Cooperation Project on Community Based Smallholder Irrigation

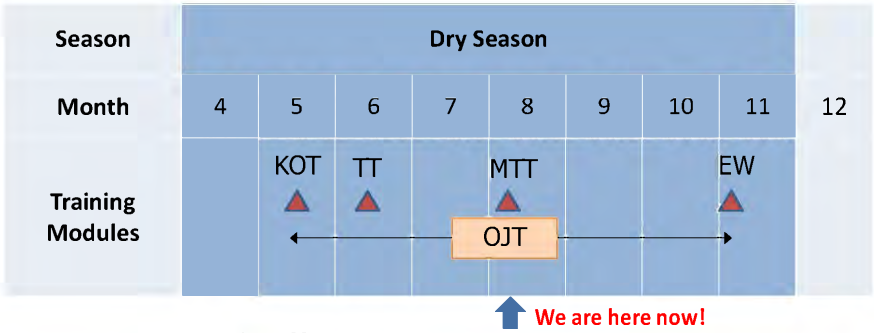
Overview of Mid-term Training

August 2015

Agenda of Mid-term Training

1. Introduction SHEP Approach and Action Plan of Northern Province by PACO (Day1, at KFI session only)
2. Presentation of Project Progress by District *(Day1)*
3. Explanation of Baseline Survey at Demonstration Site (Day1)
4. Marketing Training *(Day2,3)*
5. Organization/ Gender Training *(Day3,4)*

Annual Activity Schedule



- **KOT**: Kick-off Training
- **TT**: TSB Training
- **MTT**: Mid-term Training
- **EW**: Evaluation Workshop
- **OJT:** On the Job Training (continuous)

OJT Activities for This Year

1. Construction of simple irrigation schemes by extension officers
2. Training of fellow BEOs/CEOs by main BEOs/CEOs in simple irrigation schemes
3. Construction of 4 permanent irrigation schemes, mainly by TSB officers
   (1 in Northern , 1 in Muchinga, and 2 in Luapula)
4. Establishment of Demonstration Site (DS) in each district and practice of marketing, organization/ gender, and farming technology training that you have leant in KOT and MTT.

Schedule of OJT Activity 2015

Activity	Month 4	5	6	7	8	9	10	11
① Construction of Simple Irrigation Schemes		▬	▬	▬	▬	▬	▬	
② Training Other CEOs		▬	▬	▬	▬	▬	▬	
③ Establishing Demo Sites		▬	▬	▬	▬	▬	▬	
④ Construction of 4 permanent irrigation schemes			▬	▬	▬	▬	▬	
⑤ Conducting Marketing and Gender/ Organization Training					▬	▬	▬	
Training and Workshop		KOT	TT		MTT		EW	

Knowledge from KOT Knowledge from TT Knowledge from MTT

5

Why Demonstration Site?

6

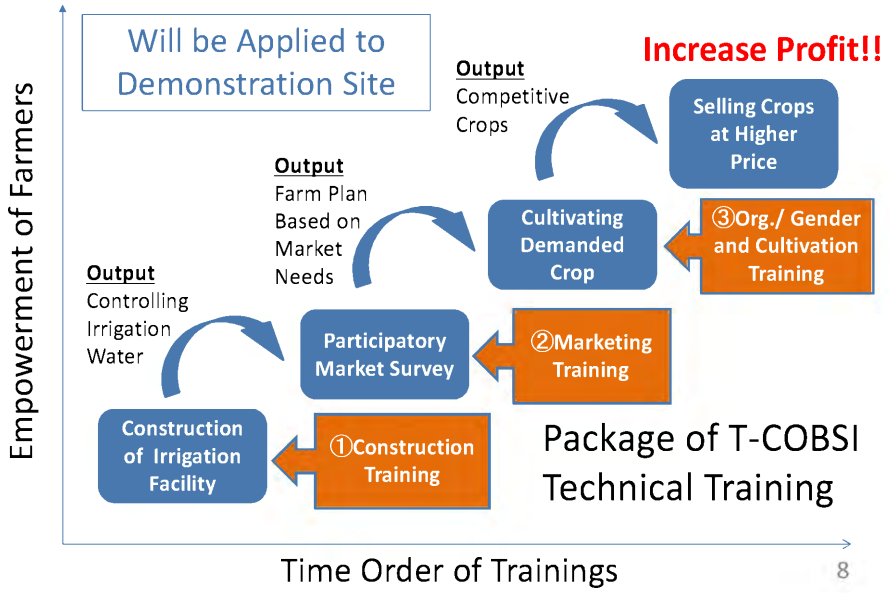
Market-Oriented Approach

	Pre-Cultivation Period	Cultivation Period	Harvesting Period	
NOT Market-oriented		Cultivation →	Marketing	Bargaining Power Decrease
Farmers Activity	- No particular activities in this period	- Cultivating crops without or limited market consideration	- Starting to look for buyers after their harvesting	
Market-oriented	Marketing →	Cultivation →	Marketing	Bargaining Power Increase
Farmers Activity	-Understanding market demand and potential buyers	- Cultivating crops selected based on market demands	- Conducting sales activity to target market stakeholders	

Start with Marketing and End with Marketing!

7

T-COBSI Strategy



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Criteria of Demonstration Site

- 1 Demonstration Site will be established from T-COBSI sites in each district
- T-COBSI Irrigation Scheme (new or improve) under responsibility of main BEOs/CEOs (who participate TOT and MTT)
- Located accessible to the market (MUST)
- Farmers group is motivated and conducting irrigation farming
- Training material will be provided (Textbook, Flipchart, Marker, Weight scale, etc.)

Activities of Demonstration Plot

1. Identification of the Site
2. Construction of Simple Weir
3. Establishment of Demonstration Plot
4. Cultivation Training
5. Baseline Survey
6. Marketing Training
7. Gender/ Organization Training
8. Evaluation Survey (1 Year Later of Baseline Survey)

Activities Based on KOT

Activities Based on MTT

Baseline Survey

- Select 10 volunteer farmers from each Demonstration Site
- Interview about farming activity of past 1 year (meaning before T-COBSI training) using the Survey Form.
- Information of all horticulture corps in Rain-fed and Irrigation Cultivation should be collected.
- Please share the result of the Baseline survey with volunteer farmers to understand their situation.

So, Let's Start Our Journey to Explore "Market-Oriented" Irrigation Farming!!

Technical Cooperation Project on
Community-Based Smallholder Irrigation

What's T-COBSI?

Introduction to the T-COBSI Project

T-COBSI Project Team

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Objectives

4 Years: May 2013 to June 2017

Overall Goal

- Increase Irrigated agricultural production in the target areas

Project Purpose

- To promote and increase irrigated land through the provision of irrigation infrastructure for smallholder farmers in the target areas

We serve the smallholder farmers

Target

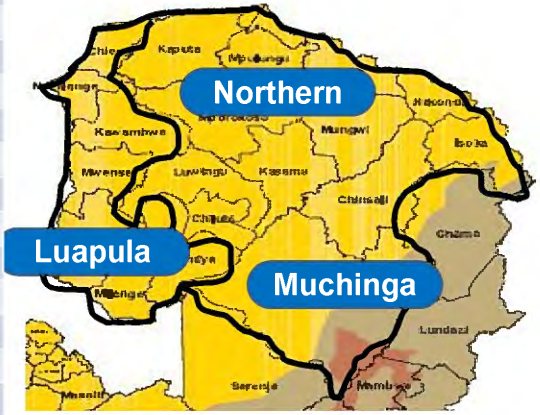
In Net Three Years

Item	Target
No. of Extension Officers Trained	150
No. of TSB Officers Trained	35
No. of Permanent Sites Developed (w/ JICA Budget)	14
No. of Permanent Sites Developed (w/ MAL Budget)	36
Area Irrigated (ha) (JICA portion)	700
No. of Farmer Groups Benefited	700

Target Area

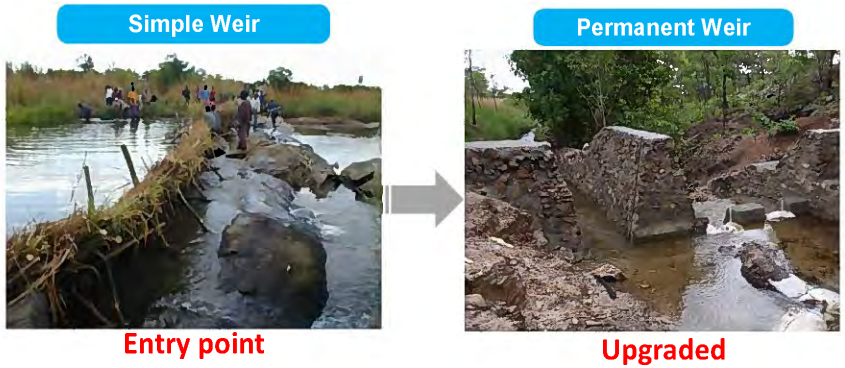
18 Districts where pilot project was implemented during the former study

Province	District
Northern	Mbala
	Mungwi
	Kasama
	Mporokoso (w/Nsama)
	Luwingu
	Mpika
Muchinga	Isoka
	Mafinga
	Siwaang'andu
	Nakonde
	Chama (invited)
Luapula	Kawambwa
	Mwansabombwe
	Mansa
	Chembe
	Mwense
	Chipili
	Milenge
	Nchelenge



Project Approach

Upgrading simple one to permanent weir



Farmers need to get used to irrigated farming through simple weirs, ensuring the successful irrigation dev. with permanent weir

What's Simple-Weir?

As an Entry Point

COBSI Approach at a Glance

- ***Simplified technology;***
  - Extension officers can be engaged in irrigation dev.
  - Farmers can construct, operate and manage
  - Constructed in a very ***short time*** (within a day)
  - Relies only on the local materials, thus ***sustainable***
  - Constructed anywhere even in ***Dambo areas***
  - ***More number*** of farmers can benefit
- ***Learning process as Capacity Development***
  - Farmers can learn w/ simple schemes as an ***entry point***
  - ***Sustainability*** is ensured when changed to permanent

Farmers themselves can construct and maintain

Simple but Functional

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Concrete Weir (L: 44 m)

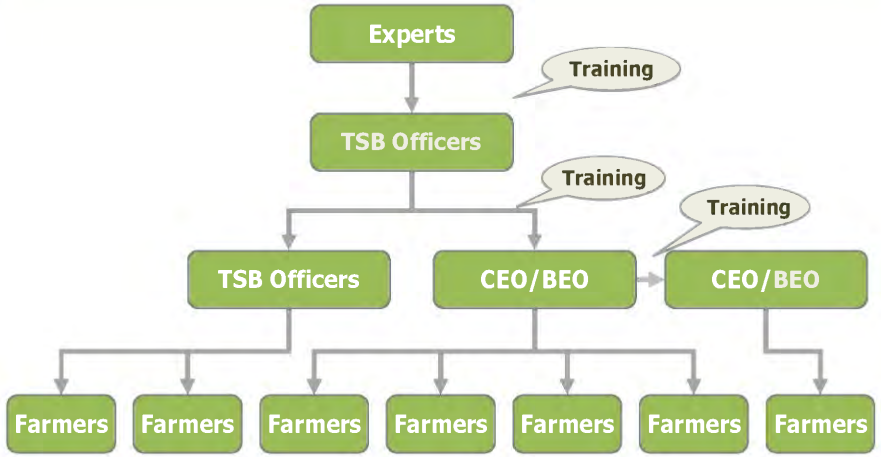
What's Permanent Weir?

Stabilized Irrigation

Wet Masonry Weir

Irrigation Dev. in Extension

Project Activities



Cascade-like dissemination of irrigation technologies

Annual Schedule

Season	Rain Season			Dry Season							
Month	1	2	3	4	5	6	7	8	9	10	11	12
Training Modules				TOT	KOT	TSB	MTT				EVW	

- **TOT**: Training of Trainers (3 days)
- **KOT**: Kick-off Training (5 days)
- **TSB**: TSB Training (4 days)
- **MTT**: Mid-term Training (4 days)
- **EVW**: Evaluation Workshop (3 days)

Kick-off Training

Water Resource Dev and Irrigated Farming

- **Overview of T-COBSI**
- **COBSI approaches and schemes**
- **Gender, Institution and Environmental Consideration**
- **Field Observation**
- **Irrigation planning**
- **O&M**
- **Theory and field practice of simple weir construction**
- **Appropriate Farming Technologies**
- **Entry planning**

Lecture on Irrigation Planning

Field Practice

On-farm Irrigation (Gravity)

Mid-term Training

Market-oriented Irrigated Agriculture (SHEP)

- Market research
- Selection of marketable crops
- Farming plan

Gender Mainstreaming

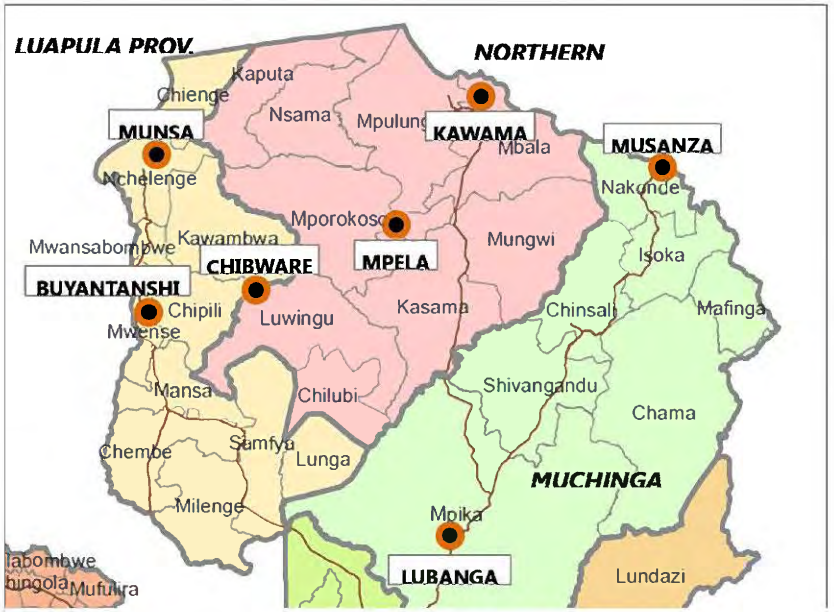
- Role of female & male on farming
- Water and land distribution

Market Research

Gender Mainstreaming

Permanent Weir Construction

7 Permanent Sites (2014)



In collaboration with Farmers

Progress

Item	Target	2014	%
No. of Extension Officers Trained	150	55	37%
No. of TSB Officers Trained	35	40	114%
No. of Permanent Sites Developed (w/ JICA Budget)	14	7	50%
No. of Permanent Sites Developed (w/ MAL Budget)	36	0	0%
Area Irrigated (ha) (JICA portion)	700	291	42%
No. of Farmer Groups Benefited	700	253	36%

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Achievement in 2014 Dry Season

Permanent Weirs: 7 sites under construction

Simple Weirs:

No. of officers trained: 93 officers

No. of site developed: 253 sites

Area irrigated: 290.6 ha

(expected to increase by the end of 2016)

No. of beneficiaries: 4,377 farmers

Achievement in 2014 by District

District	Officers Trained		Improvement Sites			New Construction sites		
	TSB	BEO/CEO	No. of Sites	No. of H/H	Total Area Irrigated	No. of sites	No. of H/H	Total Area Irrigated
	No.	No.	No.	No.	ha	No.	No.	ha
Kasama	3	4	7	183	37.0	24	589	34.3
Luw ingu	2	3	11	146	5.9	7	88	0.7
Mbala	2	2	17	232	23.2	11	117	7.3
Mporokoso/Nsama	2	4	14	447	17.4	11	238	6.2
Mungw i	2	3	19	164	29.5	9	111	10.0
Total of Northern	**11**	**16**	**68**	**1,172**	**112.9**	**62**	**1,143**	**58.4**
Muchinga	7	10	18	177	27.1	23	215	13.2
Luapula	7	28	46	569	56.7	36	457	22.3
Grand Total	**25**	**54**	**132**	**1,918**	**196.7**	**121**	**1,815**	**93.9**

Plan of This Year 2015

District	No. of Sites to Develop		No. of Fellow Officers to Train
	Improve.	New Dev.	
Mbala	17	13	6
Mungwi	12	5	5
Kasama	10	10	5
Mporokoso	14	6	6
Luwingu	10	14	3
Nsama	10	4	3
Northern	**73**	**52**	**28**
Muchinga	**29**	**53**	**27**
Luapula	**37**	**80**	**49**
Grand Total	**139**	**185**	**104**

Contribution from JICA

- **Technical guidance**
- **Trainings/workshops** (JICA rate)
- **Extension Materials** (Manual, poster, & leaflets)
- **Monitoring tools** (digital camera, forms, etc.)
- **Fuel support** (30L/BEO-CEO or 70L/TSB office)
- **Not provided:**
  - DSA/MA for the field works
  - Means of transportation other than a set amount of fuel

Expected Contribution from District

- **Sending officers in trainings**
- **Mobilization of TSB & Extension officers**
  - MA/DSA is not provided from JICA
  - CAC meeting
- **Monitoring of the officers** (monthly report)
- **Monitoring of the sites (2014-)**
- **Support on farming/marketing aspects** (i.e., SHEP approach)

MARKET ORIENTED AGRICULTURE PROMOTION

Presentation for
T-COBSI MID TERM TRAINING
10/08/15

SMALL HOLDER HOLTICULTURAL EMPOWERMENT PROJECT (SHEP)
APPROACH

Development of SHEP

- Developed by both Kenya & Japanese Governments, through JICA
- Approach very effective in raising smallholder farmer incomes from horticulture.

Development of SHEP cont'd

- It develops both technical (skills) and managerial capacity of farmers to practice Market oriented horticultural farming by developing the capacity of the farmers to conduct "**market surveys** " by themselves

Originality of SHEP

- SHEP changes farmers' mind- set on marketing, from "Grow and Sell" to "grow to Sell" so as enhance farmers' capacity to plan for the type of farming enterprise to undertake, based on available market information.
- This is the reason why SHEP starts with the Market and ends at the Market.

FABLIST FORUM

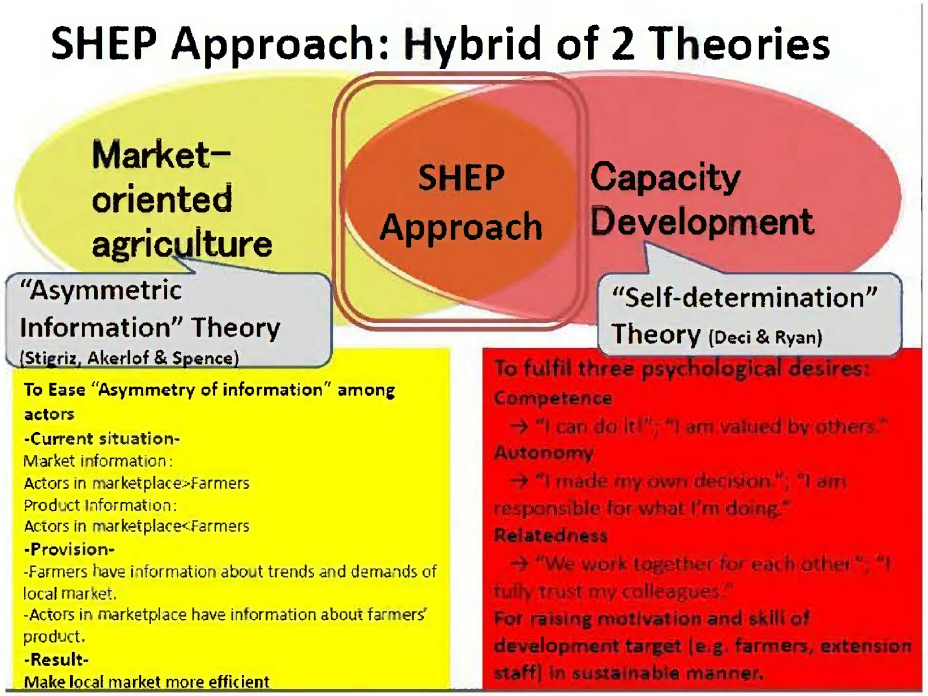
- Farm Business Linkage Stakeholder (**FABLIST**) forum for the meeting of between farmers' groups, members of the horticultural industry, and other stakeholders, meant for the farmer to expand their Knowledge and network in, farming as a business.

- As a result they establish business linkages between themselves and business service providers.

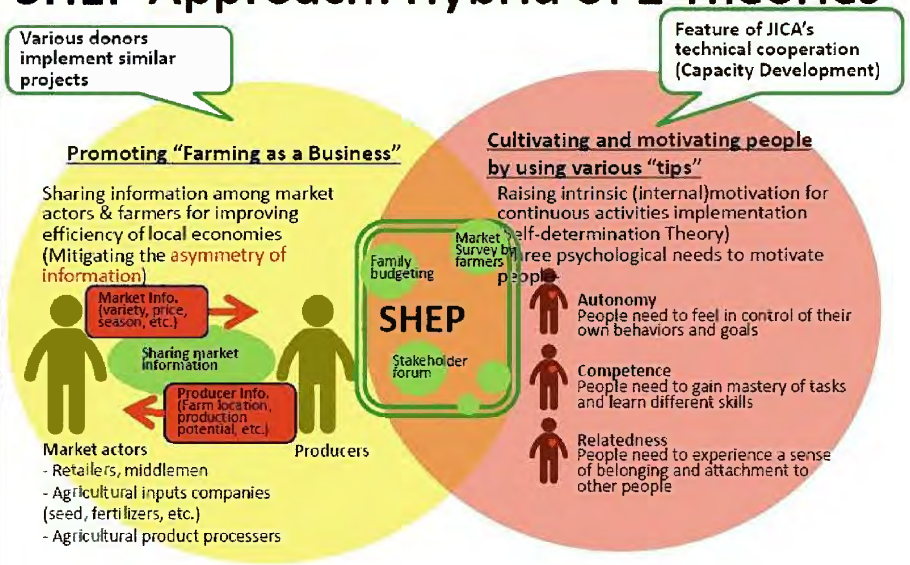
Gender

- SHEP also promotes gender equality with a clear purpose of strengthening farming couples' relationships as "partners for farm management"

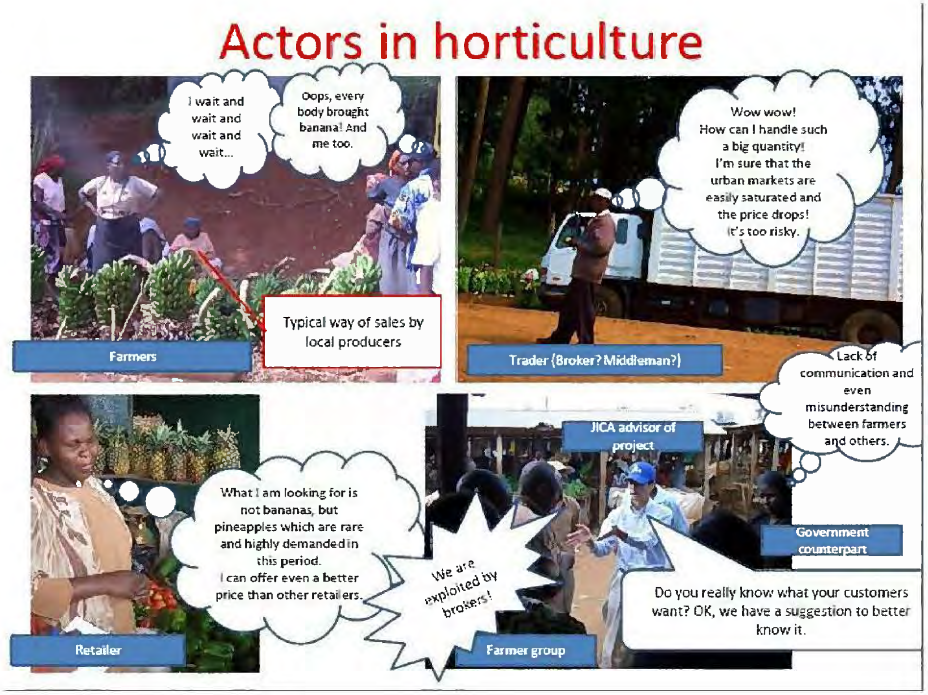
Market oriented farming!

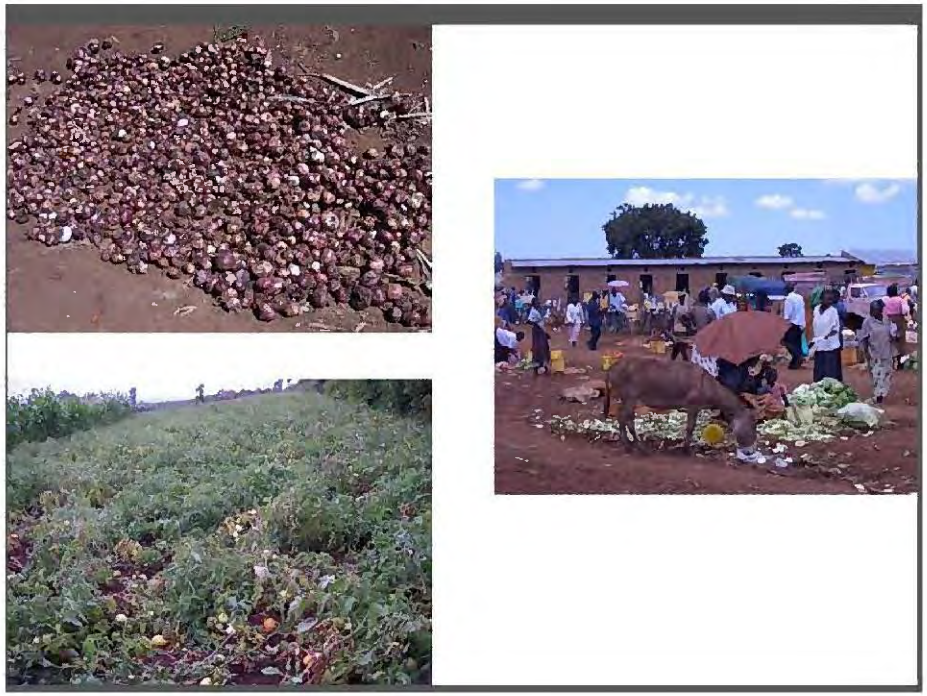


SHEP Approach: Hybrid of 2 Theories



Actors in horticulture



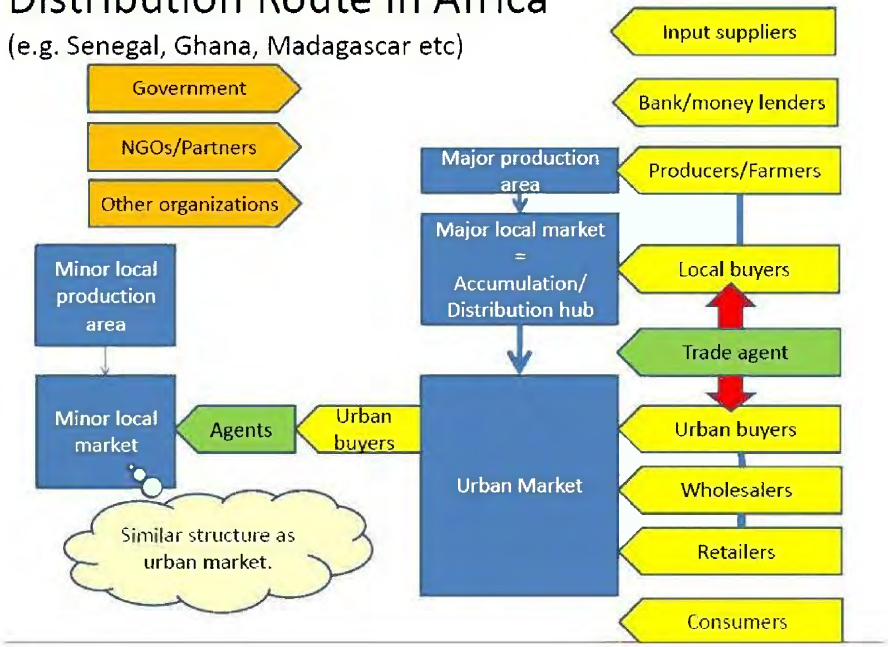


To ease Asymmetry of Information

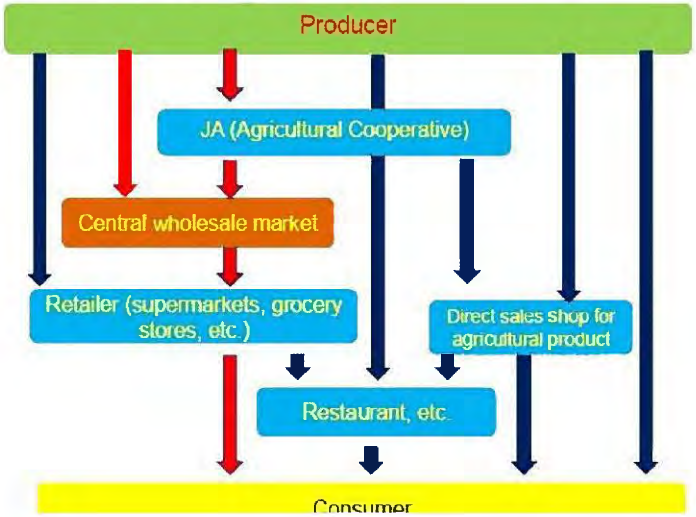
To ease Asymmetry and support Farmers

Distribution Route in Africa

(e.g. Senegal, Ghana, Madagascar etc)



Distribution route (Market channels for farmers) in Japan



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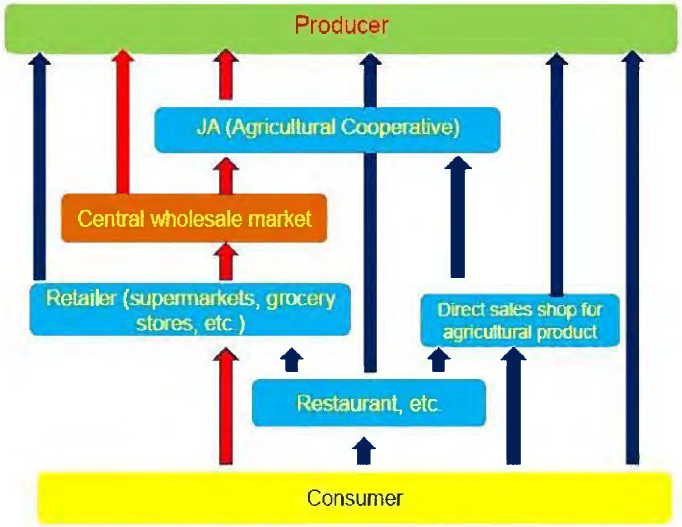
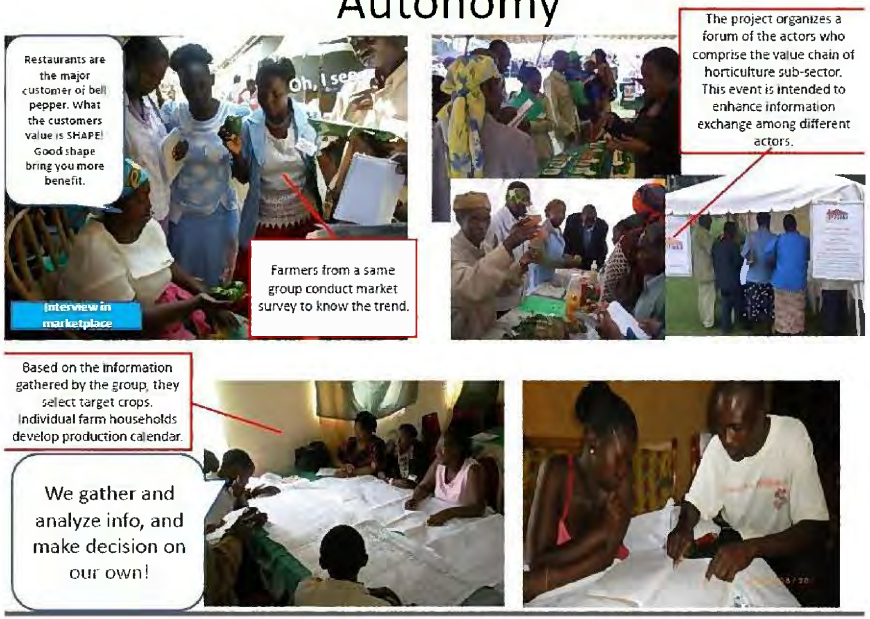
Information Feed-back



Competence

Through trainings, practice and result.

Autonomy



Relatedness

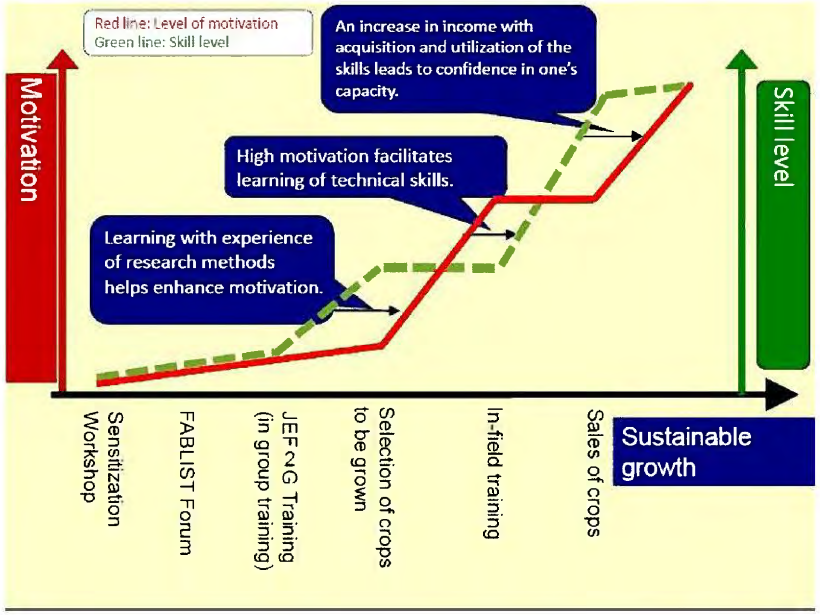
Extension staff training

Extension officers acquire the production techniques necessary for his/her group.

Feed-back to Farmers

The acquired techniques are then transferred to all the farmers.

Skills and Motivation Graph



Way forward

- Not all steps of SHEP may apply to local condition and therefore, the concept is not laid in concrete but may be modified in order to suit our (local) condition.

Way forward cont'd

- Northern province will apply this concept by engaging a small holder farmer group at Nseluka in Mungwi District as initial pilot area.
- The farmers are engaged in small holder irrigation, facilitated by T-COBSI

Arigato gozaimasu

End

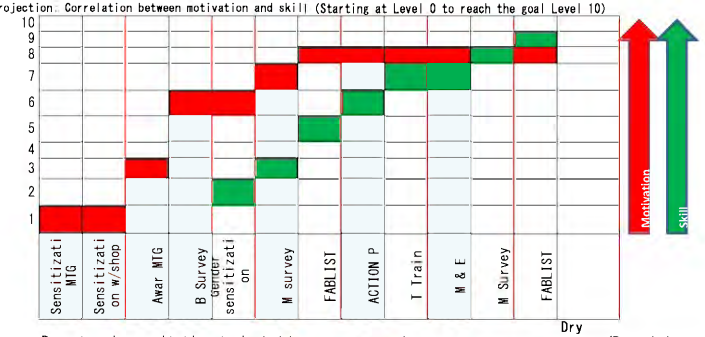
A. Banda

Paco Northern

Country ZAMBIA
Name of treinee BANDA Andrew

Institutional Framework for Implementation	
Organization Responsible	Ministry of Agriculture and Livestock
Target group	Smallholder Irrigation Farmers (Working with T- COBSI)
Target area	Nseluka Agriculture Camp- Mungwi District
Objective	To increase the income of farmers supported by the project
Total budget	3520
The period	Jan to December 2015
Section responsible for supervision	Agri- Business Department
Section responsible for implementation (Central or Local)	Dept of Agri-Business (Northern Province)
Others (Related organizations)	Irrigation Section and Farmer Association. (T- COBSI)

Projection: Correlation between motivation and skill (Starting at Level 0 to reach the goal Level 10)



Plan of Operation

Report and consultation to be held every two months. Dry season(Practicing

Activity number (Timeline)	Activity	Target farmers /group		Output/ Tasks given to participants	Supervisor	Implementer		1	2	3	4	5	6	7	8	9	10	11	12	Budget	
1	Sensitization meeting	P.S, Dir PPD	Output	Reporting & seek Aprroval	Dir Agr,P.S	PACO	Plan													Estimate	$600
	at MAL HQ	Dir Agric,ABM	Tasks	Present Report & w/plan, Show video			Actual													Actual	
2	Sensitization w/shop	Prov HODs, DACOs	Output	Introduce SHEP to officers	Dir Agr,P.S	PACO	Plan													Estimate	$120
		SMS(subject matter specialist)	Tasks	Prep material on SHEP, Show Video			Actual													Actual	
3	Awareness Meeting	Nseluka farmers,	Output	Farmers aware ofshep, Inf shared.	PACO	DACO	Plan													Estimate	$500
		BEO, CEO,Ident Stakeholders	Tasks	Focused Group Meeting		CEO	Actual													Actual	
4	Baseline survey	Nseluka farmers,	Output	Gathering information of group (farmer)	PACO	CEO,DACO	Plan														$500
		BEO, CEO,Ident Stakeholders	Tasks	making profile of group		SAO	Actual														
6	Gender Sensitization	Farmer, mkt-Com	Output	Gender mainstreeming into activities	PACO	Ceo / DACO	Plan													Estimate	$500
		CEO	Tasks	Active participation by both gender		Ceo /SAO	Actual													Actual	
7	Marketing Survey	Farmer, mkt-Com	Output	Market needs /demands analysed	DACO	Ceo / DACO	Plan													Estimate	$150
		CEO	Tasks	Administering Quationaire as task.		Ceo /SAO	Actual													Actual	
8	Fablist Forum	Service providers & Farmers	Output	Strenghening the linkages	ABM	Ceo/SAO/ABM	Plan													Estimate	$300
			Tasks	Obtaining marketing information (crop, peak period, quantity of selling)			Actual													Actual	
9	Crop selection & Ranking	Farmers group	Output	Selection of 2 crops/Annual & Crop calender	ABM	CEO	Plan													Estimate	$50
	/Preparation of Action plan		Tasks	Training for farmers group (agricultural practice)			Actual													Actual	
10	Technical training	Farmer,BEO & CEO	Output	Increased Farmer capacity	DACO/SCHO	CEO,SAO	Plan													Estimate	$200
			Tasks	Explain GAP(good agricultural practices)			Actual													Actual	
11	Field Monitor & Evaluate	Farmers	Output	Farmers adhere to proceedure	DACO	CEO /ALL	Plan													Estimate	$500
	(Backstopping)		Tasks	prepare check list, Move to field			Actual													Actual	
12	Marketing Survey	Farmer, mkt-Com	Output	Market needs /demands analysed	DACO	Ceo / DACO	Plan													Estimate	$50
		CEO	Tasks	Administering Quationaire as task.		Ceo /SAO	Actual													Actual	
13	Fablist Forum	Service providers & Farmers	Output	Entering agreement between the group and other service providers.	ABM	Ceo/SAO/ABM	Plan													Estimate	$50
			Tasks	Verifying market conditions			Actual													Actual	

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Marketing Training

T-COBSI Mid-Term Training
August, 2015

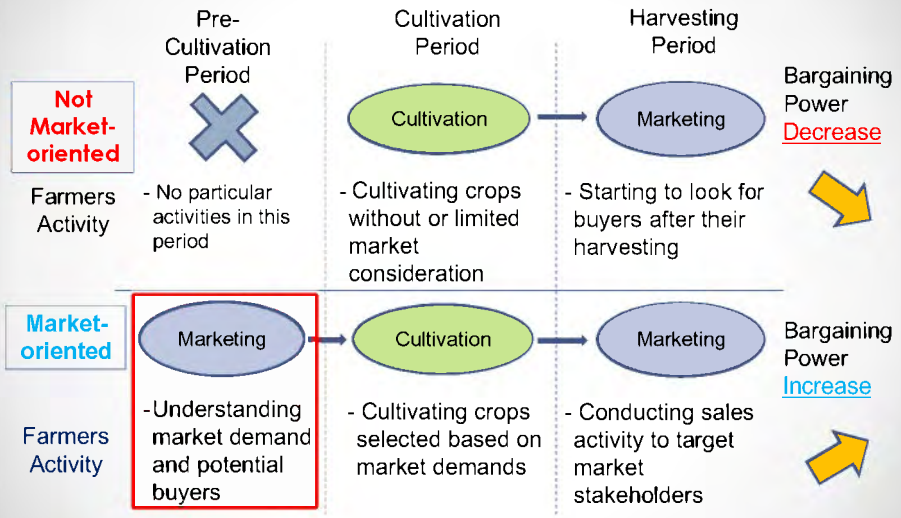
Contents

- Introduction of Market-oriented Agriculture
- Supplemental Knowledge of Market-oriented Agriculture
- Participatory Market Survey
- Farming Plan Making Based on Market Information
- Action Plan Making to Realize Farming Plan

Introduction of market-oriented Agriculture

Page 1 of Textbook

Market-Oriented Agriculture



Start with Marketing and End with Marketing

Flow of Market-oriented Agriculture

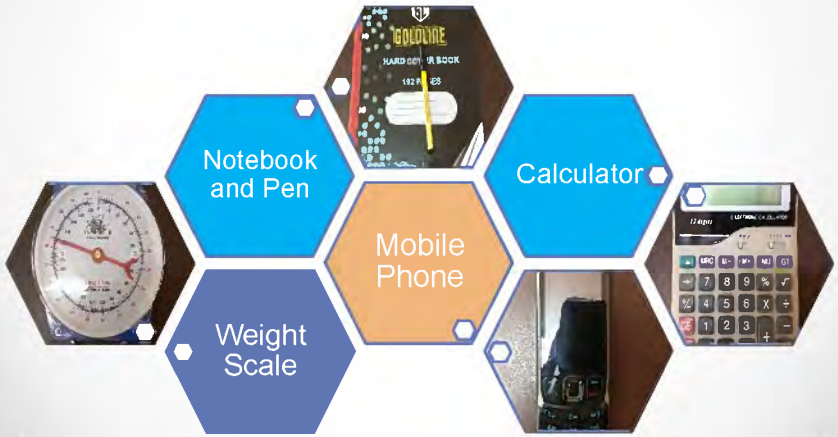
Participatory Market Survey → Farming Plan Making → Action Plan Making



Supplemental Knowledge of Market-oriented Agriculture

Page 2 of Textbook

Preparation of Necessary Material for Market-oriented Agriculture



Activity 1 Decision making by comparing price and weight

[Question] Left tomatoes cost K5 and right tomatoes cost K2. Left tomatoes weigh 0.5kg and Right Tomatoes weigh 0.3kg. Now you consider only price and weight. Which tomatoes will you buy?

Activity 2 Decision making by comparing price and weight part 2

You are a member of T-COBSI irrigation scheme. Now, your group harvested 1,000kg of tomatoes and wants to sell them to the market. According to your market survey, the retailers of Chambeshi market buy tomatoes at the price of K3.0/kg, but it costs K600 for transportation by hiring track.

[Question] A middleman comes to your field and offers you to buy 1,000 kg of your Tomato at ZK 2.3/kg. Do you sell your tomatoes to the middleman or to sell to Chambeshi market?

Textbook Page 4

Activity 3 Prepare for recording your trading activity

1. Write format of trading record on notebook refer to the sample on the textbook.
2. Decide responsible person who in charge of recording the book.
3. Continue to record sales information utilizing the form.

Required material: Notebook, Pen

Textbook Page 5

Activity 4 Prepare for recording your production cost

1. Write format of trading record on notebook refer to the sample of the textbook.
2. Decide responsible person who in charge of recording the book.
3. Continue to record sales information utilizing the form.

Required material: Notebook, Pen

Participatory Market Survey

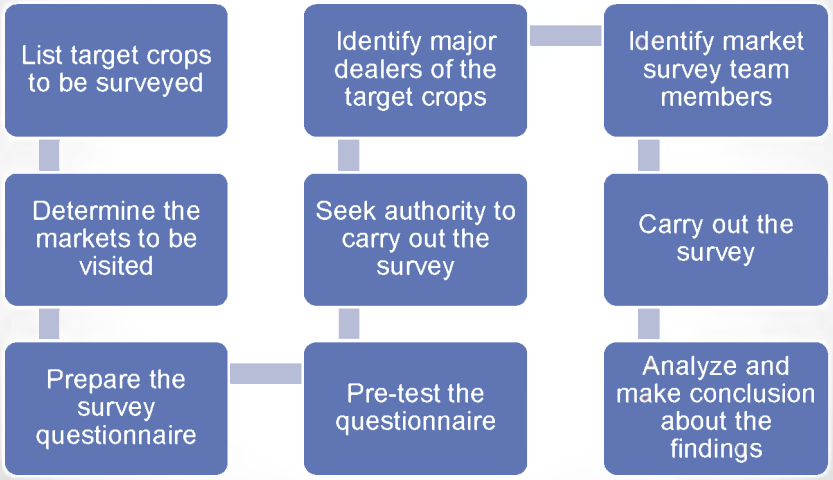
Page 6 of Textbook

Objective of Market Survey

To make profit by selling your commodities, it is very important to know market demands. If you understand market demands, you can know which is profitable crops, what quality is required, where is buyer, and when is the best time to harvest. So, it can be said that marketing activities is already started before cultivation

Conducting market survey is the first activity in order to cultivate right crop, right time and right way.

Procedure of Participatory Market Survey



Activity 5 Identifying the Crops to be surveyed

Please discuss within your group to decide the crops to be surveyed by you. You consider the crops which you are currently cultivating, and also you are interested in starting to cultivate in near future. You can also identify the target buyers (retailer, middleman), and target market.

Example of Survey List

Crop Name	Target Buyer	Target Market
Tomato	Retailer	Chambeshi
Tomato	Middleman	Chambeshi
Onion	Retailer	Luwingu
Cabbage	Retailer	Luwingu

Required material: Flipchart, Pen

Textbook Page 8

Activity 6 Preparation of Survey Questionnaire

1. Check sample questionnaire with your group members
2. Ask members the points to be revised or added to the sample of questionnaire. Please complete your own questionnaire.

Conducting Market Survey

During conducting the market survey, please pay your attention those points listed below to carry out the survey effectively.

1. Introduce interviewee about your group and purpose of your visit to obtain their cooperation.
2. Hold discussion when the interviewee is serving their customers.
3. Avoid repetitions to save a time. Remember the interviewee is very busy for their business during the survey.
4. Use friendly language and express your gratitude at the end of the interview.

Please note that the interviewees are your potential business partners in the future. The market survey also gives you a good opportunity to make a linkage with them.

Now You are Ready to Start Survey!

Scheduled Time for Market Survey: 10:45AM – 12:30PM

Farming Plan Making Based on Market Information

Page 10 of Textbook

Analysing Result of Market Survey and Selecting Target Crops

The collected information from your market survey is very important source to decide target horticulture crops of your group. However, not only profitability, but also you have to consider the risks. So, target crops should be selected by aspects of easy implement, low technical requirement, and affordable inputs in addition to market demands.

Please share the information from the market survey within your group and get ready for next activities to formulate a farming plan.

Process to Make Farming Plan

- Purpose of formulating "Farming Plan" is to confirm the schedule of farming activities in order to harvest your target crops in the most profitable period.
- Formulating "Farming Plan" has 3 steps of activities as below figure.

Textbook Page 12

Activity 7 Crop Selection Sheet

Please discuss and prepare the crop selection sheet according to the results of market survey. The sample of crop selection sheet is in the textbook

1. List down the crops covered during the market survey.
2. Discuss market survey findings for each commodity with group members
3. Fill each column with accurate information for all candidate crops using: market survey results, crop production and income records and other available information

The information of crop selection sheet will be a base to decide target crops for next cultivate season of your group

Required material: Flipchart, Marker

Target Crop Selection Criteria

After completing the "Crop Selection Sheet", please select 2 target crops by your decision based on the formation in the "Crop Selection Sheet". The target crop must be selected by profitability to aim to harvest in high demand season.

However, you cannot ignore your major production challenge. For example, you cannot start cultivation when your field in marshland is submerged by water. In such a case, please discuss to try to meet the 2nd peak of market demands to make your farming activity to be practical.

Textbook Page 13

Activity 8 Crop Ranking Sheet (1)

Please select target crops by following the process.

1. Prepare the "Crop Ranking Sheet" as sample of the textbook.
2. On the table of the "1st Crop", Please list the crops which are analyzed on the "Crop Selection Sheet".
3. Prepare voting papers and distribute them among group members.
4. Each group member writes down his/her 1st preferred crops on the voting paper

Textbook Page 13

Activity 8 Crop Ranking Sheet (2)

5. Collect the voting papers and count the votes, the crop chosen by more members becomes the 1st Target Crop
6. Fill up "1" on selected crop's column of "Crop Rankin" of the "Crop Ranking Sheet".
7. Select the 2nd Target Crop from remaining crops listed through same voting procedure.
8. Fill up "2" on selected crop's column of "Crop Rankin" of the "Crop Ranking Sheet".

Required material: Flipchart, Marker

Textbook Page 14

Activity 9 Making Farming Plan for Selected Crops

After completion of activity 8, please make farming schedule for those selected crops as a farmers' group. Farming schedule should be designed to harvest your target period of high demand season, which you identify in the market survey and its analysis. Please make sure farming schedule is practical and try to avoid to ignorance of your condition of farming environment.

Required material: Flipchart, Marker

Formulating Action Plan to Carry out Farming Plan

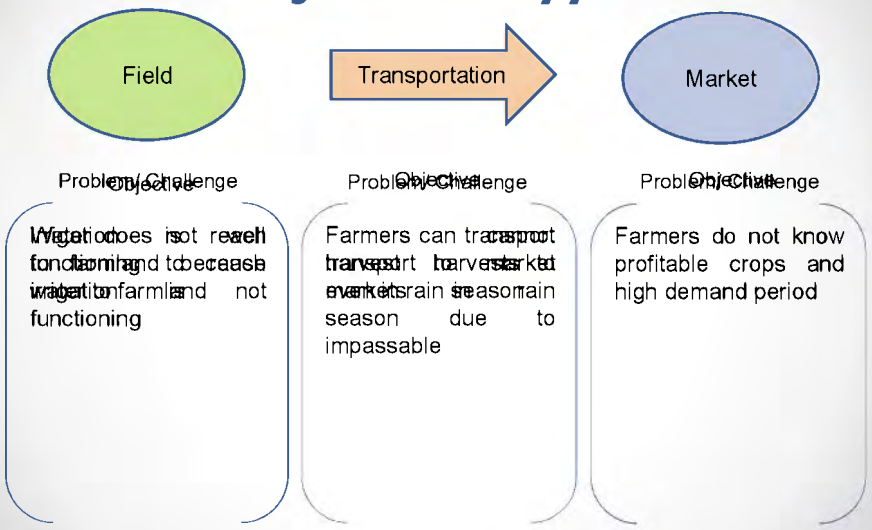
Page 16 of Textbook

Making Action

- Purpose of formulating "Action Plan" is to mitigate problems and challenge and to clarify corrective action in order to practice your "Farming Plan" by a group.
- Formulating "Action Plan" has 3 steps of activities as below figure.

Textbook Page 17,18

Problem Analysis



Textbook Page 19

Action Plan Making

Objective	Activity	Stage	Resources	Implementer	Schedule	Monitoring Person
Irrigation is well functioning to reach water to farmland	Clearing weir and fallow	Before planting	Community work, hoe, shovel	Members	May 2015	Committee members
Farmers can transport harvests to market even in rain season	Maintenance the village road	Before rain season	Community work, hoe, shovel	Members	September 2015	Committee members
Farmers know profitable crops and highest demand period	Conducting market survey	Before planting and before harvesting	Funds, notebook, pen, mobile phone	Marketing Committee	April and October 2015	Chair persons

Activity 10 Making Problem Map

1. Draw a map of surrounding area of the group. The map has to show group's area up to the target market
2. Identify some of the Problems/ Challenges faced at each stage of the route to the market from the field (problem/ challenge should be specific to conduct your faming plan).
3. Describe on the flip chart and present to the participant.

Required material: Flipchart, Pen

Activity 11 Making Objective Map

1. Draw a map of surrounding area of the group.(same as Problem Map)
2. Replace each Problem/ Challenge in the Problem Map with a corresponding objective (converting expression in positive way) in the Objective Map
3. Describe on the flip chart and present to the participant.

Required material: Flipchart, Marker

Last Activity!! Making Action Plan

1. According to the Objective Map formulated in former activity, fill out the form of the Action Plan referring the sample on next page. Action plan is defined to attain Objectives which are identified former activity.
2. Make consensus with the group and present to other participants

Required Material: Flipchart and Marker

Thank You Very Much

T-COBSI Marketing Technical Manual

for Market-Oriented Farming

August 2015

Technical Cooperation Project on Community Based Smallholder Irrigation (T-COBSI)

I

Table of Contents

Step 1 Getting Started

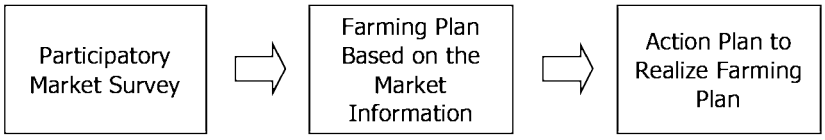
1. Market-oriented Approach

Please remind your current farming activity. How do you decide type of crop to plant and time to start to cultivate? If you are not considering "Market" at that time, this training programme will be a good opportunity to start Market-oriented farming in order to make more profit from your farming activity than before.

To conduct Market-oriented farming, farmers have to decide right crops and right time to cultivate to meet markets demand. In order to do so, you have to "think" very well. Thinking is comparing something with something to seek the best way. For example, farmer can comparing the selling price at local market with the price at district market, or comparing the selling price last year with the price this year and so on. In order to do so, farmers have to fetch reliable market information by themselves and utilize the information for their decision making.

Therefore, the process of Market-oriented farming of T-COBSI consists of 3 main components, namely 1) Conducting participatory market survey by farmers, 2) Making farm plan based on market information they collected, and 3) Making action plan to realize their farm plan. This training manual is designed for farmers to lean these 3 components step by step.

Flow of Main Components of T-COBSI Market-oriented Approach



2. Preparing Necessary Materials

Before starting activity of Market-oriented approach, please make sure your farmers' group to prepare following basic materials. Those materials are indispensable to practice all T-COBSI marketing activity effectively.

1) Notebooks and Pens

Notebooks and Pens are the most important material you have to have. You have to record all Information regarding your agricultural activity, such as production cost, harvested volume, selling price, buyer contact address, and so on. You must remember that you cannot make any rational decision without that information. For example, if you do not record how much you spent money to produce Tomato, you will never know much is your profit from selling them. Moreover, you cannot even know you are earning money or losing money.

2) Mobile Phone

Mobile phone is very powerful tool to communicate with outsiders of your community. Even if your farmers' group is located in remote area from the market, mobile phone helps you to communicate with buyers.

3) Weight Scale

Weight scale is very important to have to conduct commercial agriculture. For commercial activity, weight and measure is used to measure how much profit is from the trade. If you decide the price by basket, you cannot know the price is appropriate or not because you do not have any standard to compare with it. Meanwhile, if you decide the price by the unit of "kg", you can compare with the trend of market price, your past trade, or any other price information presented by "kg". So, you can know the price is fair or not.

STEP 2 Supplemental Knowledge for Market-oriented Approach

1 Selling Your Commodity by Weight

It is very important to sell your commodity by weight to know how much you earn from your products. Common language to describe amount of commodity in the world of business is unit of "kg". That means that once you enter the world of business, you have to use "kg" in your every business activity, such as negotiation with middleman, checking market price, and also recording your past trade, and so on to protect your profit.

Activity 1 Decision making by comparing price and weight

Question: Left tomatoes cost K5 and right tomatoes cost K2. Left tomatoes weigh 0.5kg and Right Tomatoes weigh 0.3kg. Now you consider only price and weight. Which tomatoes will you buy?

Required Material: Your concentration

Farmer should calculate benefit of trade through selecting market to sell based on calculation of transportation cost, amount of commodity, and gap of selling price of each target market.

Activity 2 Decision making by comparing price and weight part 2

You are a member of T-COBSI irrigation scheme. Now, your group harvested 1,000kg of tomatoes and wants to sell them to the market. According to your market survey, the retailers of Chambeshi market buy tomatoes at the price of K3.0/kg, but it costs K600 for transportation by hiring track.

Question: A middleman comes to your field and offers you to buy 1,000 kg of your Tomato at ZK 2.3/kg. Do you sell your tomatoes to the middleman or to sell to Chambeshi market?

Required Material: Your concentration more

2. Recording Your Business Activity

1) Recording Selling Amount

Recording your business activity is important to know how you conduct. Please record summary of your past trading with buyer on the notebook. This information is very important for your future activity. Please continue keeping record from now on. Make sure which unit you apply in each trade because it is very important when you compare the record with other information.

Activity 3 Prepare for recording your future trading activity (20 min)

1. Write format of trading record on notebook refer to the sample in the page 4.
2. Decide responsible person who in charge of recording the book.
3. Continue to record information of your sales activity utilizing the foam you made.

Required material: Notebook, Pen

2) Recording Production Costs

You cannot know how much is your profit from your farming activity if you know only selling record. You also need to know how much the cost for your production in order to know your earning money or losing money by your farming activity. Therefore, without selling record and production cost, you cannot judge your business is good or bad. Keeping production cost is very important.

Activity 4 Prepare for recording your production cost (20 min)

1. Write format of trading record on notebook refer to the sample of the page 5.
2. Decide responsible person who in charge of recording the book.
3. Continue to record information of your production costs utilizing the foam you made.

Required material: Notebook, Pen

Note:

Sample of Trading Record

Date	Commodity Name	Unit price (ZK/kg)	Selling Amount (kg)	Total price (ZK)	Buyer's name	Buyer's Contact Number	Remarks
21/6/2015	Tomato	3/kg	100 kg	300	Kelvin Simukoko	0979291515	
25/6/2015	Tomato	75/crate	2 crate	150	Ackson Mbewe	0979120338	
4/7/2015	Cabbage	100/bag(75kg)	2bag(75kg)	200	Mufarali Sifaya	0977372247	
24/7/2015	Onion	40/gallon	4gallon	160	Masaya Fukumoto.	0969800877	

You can review your past trading record, eg, selling price, amount, and buyer's name. It helps that your business becomes more transparency and you are able to make more reasonable decision.

Sample of Production Cost Record

Commodity Name: Cultivation Area:

Cultivation Start Date: Cultivation Ended (Harvested) Date:

Date/ Activity	Cost Items (ZK)							
	Seeds	Fertilizer	Pesticide	Compost Materials	Hiring Labor	Transportation to Market	Other Costs ( )	Other Costs ( )
Jan-15								

* You must record production costs by each commodity

Step 3 Selecting Target Crops and Market for Survey

Objective of Market Survey

To make a profit by selling your commodities, it is very important to know market demands. If you understand market demands, you can know which is profitable crops, what quality is required, where is buyer, and when is the best time to harvest. So, it can be said that marketing activities is already started before cultivation. Conducting market survey is the first activity in order to cultivate right crop, right time and right way.

Procedure of market survey

-List target crops to be surveyed
-Determine the markets to be visited
-Prepare the survey questionnaire
-Pre-test the questionnaire
-Seek authority to carry out the survey
-Identify major dealers of the target crops
-Identify market survey team members
-Carry out the survey
-Analyze and make conclusion about the findings

As first step of market survey, let identify your target crops to be surveyed.

Activity 5 Identifying the Crops to be surveyed

Please discuss within your group to decide the crops to be surveyed by you. You consider the crops which you are currently cultivating, and also you are interested in starting to cultivate in near future. You can also identify the target buyers (retailer, middleman), and target market.

Example of Survey List

Crop Name	Target Buyer	Target Market
Tomato	Retailer	Chambeshi
Tomato	Middleman	Chambeshi
Onion	Retailers	Luwingu
Cabbage	Retailers	Luwingu

Required material: Flipchart, Pen

Step 4 Preparation of the Market Survey Questionnaire

Next step is to identify what time of information to collect from the survey. Please refer the sample questionnaire on next page and discuss within the group to revise it.

Activity 6 Preparation of Survey Questionnaire

1) Check sample questionnaire with your group members
2) Ask members the points to be revised or added to the sample of questionnaire. Please complete your own questionnaire.

Required material: Survey form, Pen

Note:

Sample of Market Survey Questionnaire

Date: Irrigation Scheme Name:

Market Name: Market Location:

	Name & Contact of the Dealer	Crop & Variety	Crop's Quality of Market Requirements	Peak Demand (Months)	Quantity (kg) & Frequency (daily/ weekly etc.) of Supply	Place of Production	Purchasing Unit Price (ZK/ kg)	Mode of Payment	Terms of Payment	Marketing Condition	Dealer Willingness to Purchase the Crops from the Group (*)
E (	lvis Mayson 977436768	Tomato	Mixed with ripe and unripe	Jun-Sep	100kg, 2times/week	- Mbala - Mungwi	ZK3/kg	Cash	Immediately	Farmers bring tomato to market by themselves	I am willing if farmer offers good price. From next harvest
M (	ichael Banda 977948418	Cabbage	Green color and Fresh	Oct-Nov	6bag(50kg), 1time/week	- Mungwi - Local	ZK40/bag(50kg)	Cash	Immediately	Bulk amount (more than 2 ton)	Yes Any time.
C (	hristine Phiri 9768515295	Red Onion	Properly dried	Jan-Apr	2gallon, 2times/week	- Mbala - Local	ZK40/gallon	Cash	Immediately	Weekly supply	Yes Any time
E (	ster Bwalya 9763502946	Eggplant	Fresh and white color	Oct-Nov	3Bag(25kg), 3time/week	- Local	ZK30/bag(25kg)	Cash	Immediately or after trading	No damages	Yes Any time

*(If Yes, How Soon? If no, give reasons.)

Step 5 Conducting Market Survey

During conducting the market survey, please pay your attention those points listed below to carry out the survey effectively.

1) Introduce interviewee about your group and purpose of your visit to obtain their cooperation.
2) Hold discussion when the interviewee is serving their customers.
3) Avoid repetitions to save a time. Remember the interviewee is very busy for their business during the survey.
4) Use friendly language and express your gratitude at the end of the interview.

Please note that the interviewees are your potential business partners in the future. The market survey also gives you a good opportunity to make a linkage with them.

Now you are ready to start survey!!

Step 6 Analysing Result of Market Survey and Selecting Target Crops

The collected information from your market survey is very important to decide two major horticulture crops through crop ranking. Crops should be selected by aspects of easy implement, low technical requirement, and affordable.
Please share the information within your group and discuss two major horticulture crops of next cropping season.

Activity 7 Crop Selection Sheet

Please discuss and prepare the "Crop Selection Sheet" according to the results of market survey. The sample of the "Crop Selection Sheet" is in the page 12 of the textbook

1) List down the crops covered during the market survey.
2) Discuss market survey findings for each commodity with group members
3) Fill each column with accurate information for all candidate crops using: market survey results, crop production and income records and other available information

The information of "Crop Selection Sheet" will be a base to decide target crops for next cultivate season of your group

Required material: Flipchart, Marker

After completing the "Crop Selection Sheet", please select 2 priority crops by your decision based on information in the "Crop Selection Sheet". The target crop must be selected by profitability to aim to harvest in high demand season, however, you cannot ignore your major production challenge. For example, you cannot start cultivation when your field in marshland is submerged by water. In such a case, please discuss to try to meet the 2nd peak of market demands to make your farming activity to be practical.

Activity 8 Crop Ranking Sheet

Please select target crops by following the process.

1) Prepare the "Crop Ranking Sheet" as sample on the page 13 of the textbook.
2) On the table of the "1st Crop", Please list the crops which are analyzed on the "Crop Selection Sheet".
3) Prepare voting papers and distribute them among group members.
4) Each group member writes down his/her 1st preferred crops on the voting paper
5) Collect the voting papers and count the votes, the crop chosen by more members becomes the 1st Target Crop
6) Fill up "1" on selected crop's column of "Crop Ranking" of the "Crop Ranking Sheet".
7) Select the 2nd Target Crop from remaining crops listed through same voting procedure.
8) Fill up "2" on selected crop's column of "Crop Ranking" of the "Crop Ranking Sheet".

Required material: Flipchart, Marker

Notes:
-If the number of votes ties, let the group members to vote again for only those crops
-Voting result is transferred to the ranking column of the "Crop Selection Sheet".

-High ranked crops (crop no 1 & 2) are the target crops of the farmers' group.
-However, group members can continue to grow other low ranked crops individually.
-This exercise should be conducted regularly after every market survey.

Activity 9 Making Farming Plan for Selected Crops

After completion of activity 8, please make farming schedule for those selected crops as a farmers' group. Farming schedule should be designed to harvest your target period of high demand season, which you identify in the market survey and its analysis. Please make sure farming schedule is practical and try to avoid to ignorance of your condition of farming environment.

Required material: Flipchart, Marker

Note:

Sample of Crop Selection Sheet

Date
Camp Name:
Irrigation Scheme Name:
District Name:
Province Name:

Crop & Variety Name	Consumed by Local	Experience in cultivating the group	Month of planting	Month of Harvesting	Major production challenge	Average marketable yield per Lima (kg/Lima)	Average unit price (ZK/kg)	Total income per cropping season per Lima (ZK)	Cost of production per Lima (ZK)	Estimated net income per Lima (ZK)	Main market(s)	Major marketing challenge	Remarks	Ranking
Tomato	Yes	Yes	May	Jul	Leaf blight disease	750	3	2,250	500	1,750	Chambeshi	Easy to get damage during transportation	Likely to be affected by disease	1
Water melon	Yes	Yes	June	August	Requires extreme care	800	2	1,600	800	800	Nakonde	Market is far	A need to spray fungicide	
Onion	Yes	Yes	Mar	June	None	450	4	1,800	500	1,300	Mbala	Buyer wants bulk amount (1 ton)		2
Cabbage	Yes	Yes	April	June	difficult to control Pests	800	1.5	1,200	500	700	Mansa	Buyer is few		
Eggplant	Yes	Yes	June	Nov	None	350	1.2	420	200	220	Luwingu	None		

Sample of Crop Ranking Sheet

1st Crop

Name of Crops	No. of Members selected the Crop/ No. of total	Crop Ranking
Tomato	9/17	1
Watermelon	2/17	
Onion	4/17	
Eggplant	1/17	
Cabbage	1/17	

2nd Crop

Name of Crops	No. of Members selected the Crop/ No. of total	Crop Ranking
Watermelon	2/17	
Onion	13/17	2
Eggplant	1/17	
Cabbage	1/17	

Sample of Farming Plan for 1st Target Crop

Date Irrigation Scheme: Crop: Tomato

Camp: District: Province:

Month		May				June				July				August			
Week		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Purchase of Inputs	√															
2	Land Preparation	√	√														
3	Nursery Sowing			√													
4	Transplanting						√										
5	Top Dressing Fertilizer Application				√		√				√						
6	Pest Disease Control				√		√				√		√				
7	Weeding					√					√		√				
8	Harvesting																√
9	Marketing	√				√					√						√
10																	

Sample of Farming Plan for 2nd Target Crop

Date Irrigation Scheme: Crop: Onion
Camp: District: Province:

Month		September				October				November				December			
Week		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Purchase of Inputs	√															
2	Land Preparation	√	√														
3	Nursery Sowing			√													
4	Transplanting						√										
5	Top Dressing Fertilizer Application				√		√										
6	Pest Disease Control					√		√		√		√			√		
7	Weeding					√		√				√			√		
8	Harvesting																√
9	Marketing	√				√		√				√					√
10																	

Step 7 Making Problem Map

Focusing on the selected crops above, Problem Analysis will be done here by identifying the major challenges/problems faced by farmers at production, transportation and marketing levels.

Activity 10 Making Problem Map

1) Draw a map of surrounding area of the group. The map has to show group's area up to the target market
2) Identify some of the Problems/ Challenges faced at each stage of the route to the market from the field (problem/ challenge should be specific to conduct your farming plan).
3) Describe on the flip chart and present to the participant.

Required material: Flipchart, Marker

Step 8 Making Objective Map

Activity 11 Making Objective Map

1) Draw a map of surrounding area of the group.(same as Problem Map)
2) Replace each Problem/ Challenge in the Problem Map with a corresponding objective in the Objective Map
3) Describe on the flip chart and present to the participant.

Required material: Flipchart, Marker

Step 9 Making Action Plan

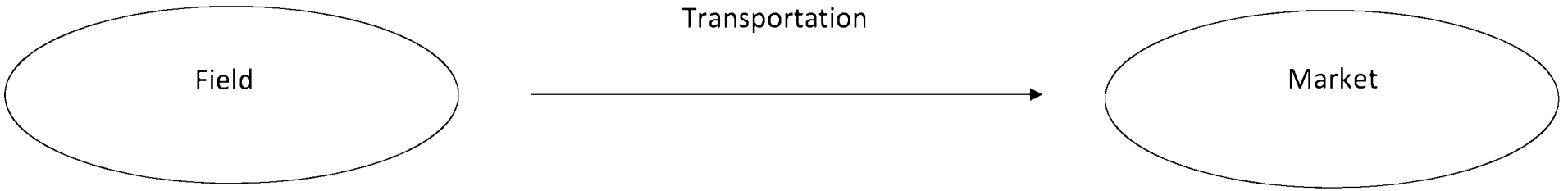
After your complete your Objective Map, it is a time to think how your identified Objective to be realized. Please discuss about which kind of action you have to take to success your farming plan.

Activity 12 Making Action Plan

1) According to the Objective Map formulated in former activity, fill out the form of the Action Plan referring the sample on next page. Action plan is defined to attain Objectives which are identified former activity.
2) Make consensus with the group and present to other participants

Required Material: Flipchart, Marker

Sample of Problem Map



Problems/ Challenges

- Water does not reach to the farmland because irrigation is not functioning
- Farmers pay high cost of renting farmland since farmers do not have own farm land
- Crops are damaged by drought
- Crops are attacked by pests (*Grasshopper*)
- etc.

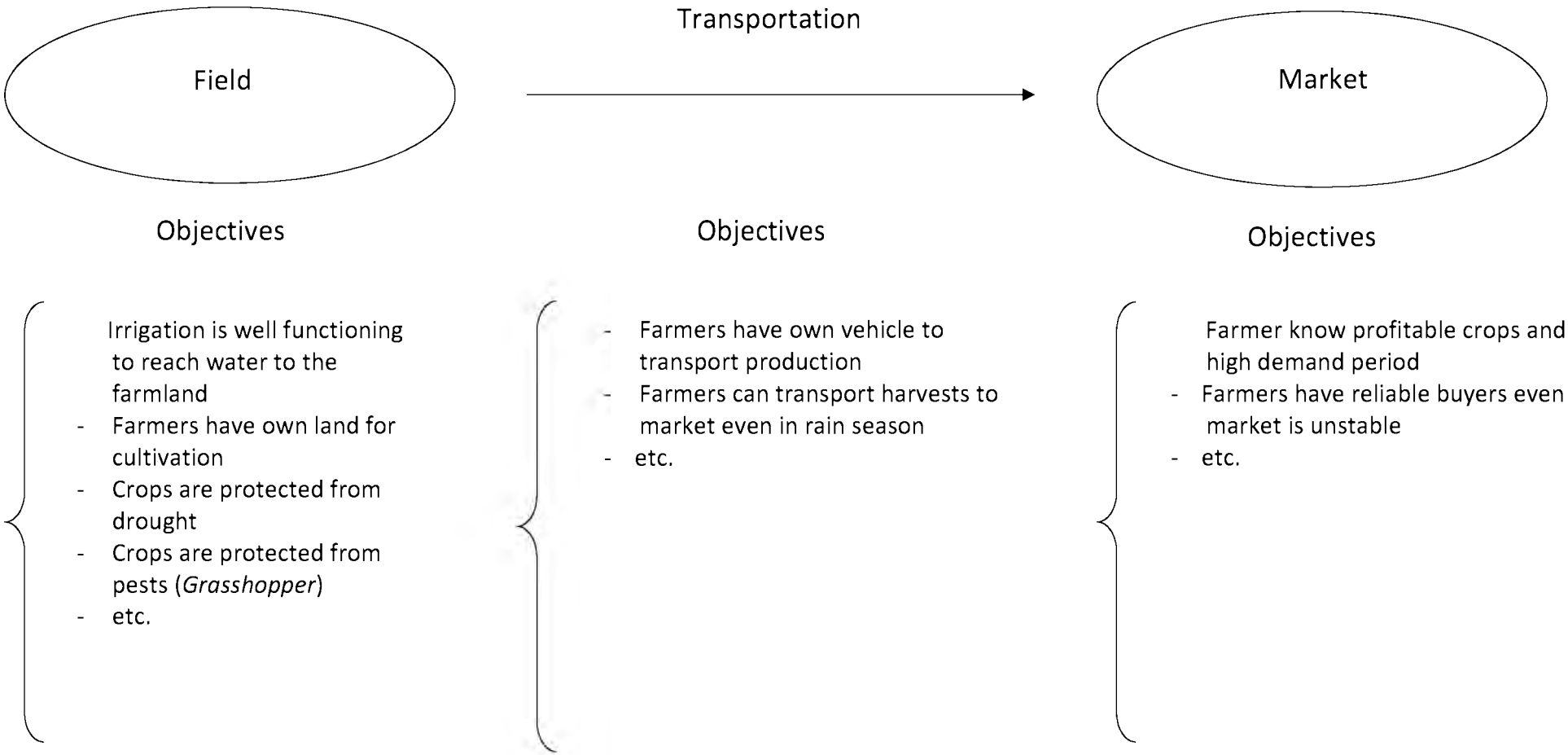
Problems/ Challenges

- Farmers do not have its own vehicle to transport production
- Farmers cannot transport harvests to market in rain season due to Impassable roads
- Tomatoes get damaged during transportation
- etc.

Problems/ Challenges

- Farmers do not know profitable crops and high demand period
- Farmer cannot have reliable buyer since market is unstable.
- etc.

Sample of Objective Map



Sample of Action Plan

Date Irrigation Scheme Name:
Camp Name: District Name: Province Name:

Objective	Activity	Stage	Resources	Implementer	Schedule	Monitoring Person
Irrigation is well functioning to reach water to the farmland	Cleaning weir and fallow	Before planting	Community work, Hoe, Shovel	Members	May 2015	Committee Members
Farmers have own land for cultivation	Purchasing the farmland	Before planting	Funds	Members	December 2015	Chairperson
Crops are protected from drought	Reclaiming the farm ponds	Before planting	Funds, hoe, shovel	Members	May 2015	Committee Members, CEO
Crops are protected from pests (*Grasshopper*)	Catching those pests (Grasshopper)	At planting	Bags	Members	June 2015	Committee Members, CEO
Farmers can transport harvests to market even in rain season	Reclaiming the village road	Before harvesting,	Community work, hoe	Members	July 2015	Committee Members
Farmer know profitable crops and high demand period	Conducting market survey to know profitable crops and high demand month	Before planting	Funds, notebook and pen	Market Committee	April and October 2015	Chairperson
Farmers have reliable buyers even market is unstable.	Making a list of reliable buyers	At any stage when information obtained	Notebook and pen	Market committee	Continuously	Chairperson

Blank Forms

Market Survey Questionnaire

Date: Irrigation Scheme Name:

Market Name: Market Location:

Name & Contact of the Dealer	Crop & Variety	Crop's Quality of Market Requirements	Peak Demand (Months)	Quantity (kg) & Frequency (daily/ weekly etc.) of Supply	Place of Production	Purchasing Unit Price (ZK/ kg)	Mode of Payment	Terms of Payment	Marketing Condition	Dealer Willingness to Purchase the Crops from the Group (*)

*(If Yes, How Soon? If no, give reasons.)

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Crop Selection Sheet

Date
Camp Name:
Irrigation Scheme Name:
District Name:
Province Name:

Crop Name &Variety	Consumed by Local	Experience in cultivating the group	Month of planting	Month of harvesting	Major production challenge	Average marketable yield per Lima (kg/Lima)	Average unit price (ZK/kg)	Total income per cropping season per Lima (ZK)	Cost of production per Lima (ZK)	Estimated net income per Lima (ZK)	Main market(s)	Major marketing Challenge	Remarks	Ranking

AP-I-I-253

Crop Ranking Sheet

1st Crop

Name of Crops	No. of Members selected the Crop/ No. of total	Crop Ranking

2nd Crop

Name of Crops	No. of Members selected the Crop/ No. of total	Crop Ranking

AP-1254

Farming Plan for 1st Target Crop

Date Irrigation Scheme Name: Crop Name:

Camp Name: District Name: Province Name:

	Month															
	Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Purchase of Inputs																
2	Land Preparation																
3	Nursery Sowing																
4	Transplanting																
5	Top Dressing Fertilizer Application																
6	Pest Disease Control																
7	Weeding																
8	Harvesting																
9	Marketing																
10																	

AP-I-I-255

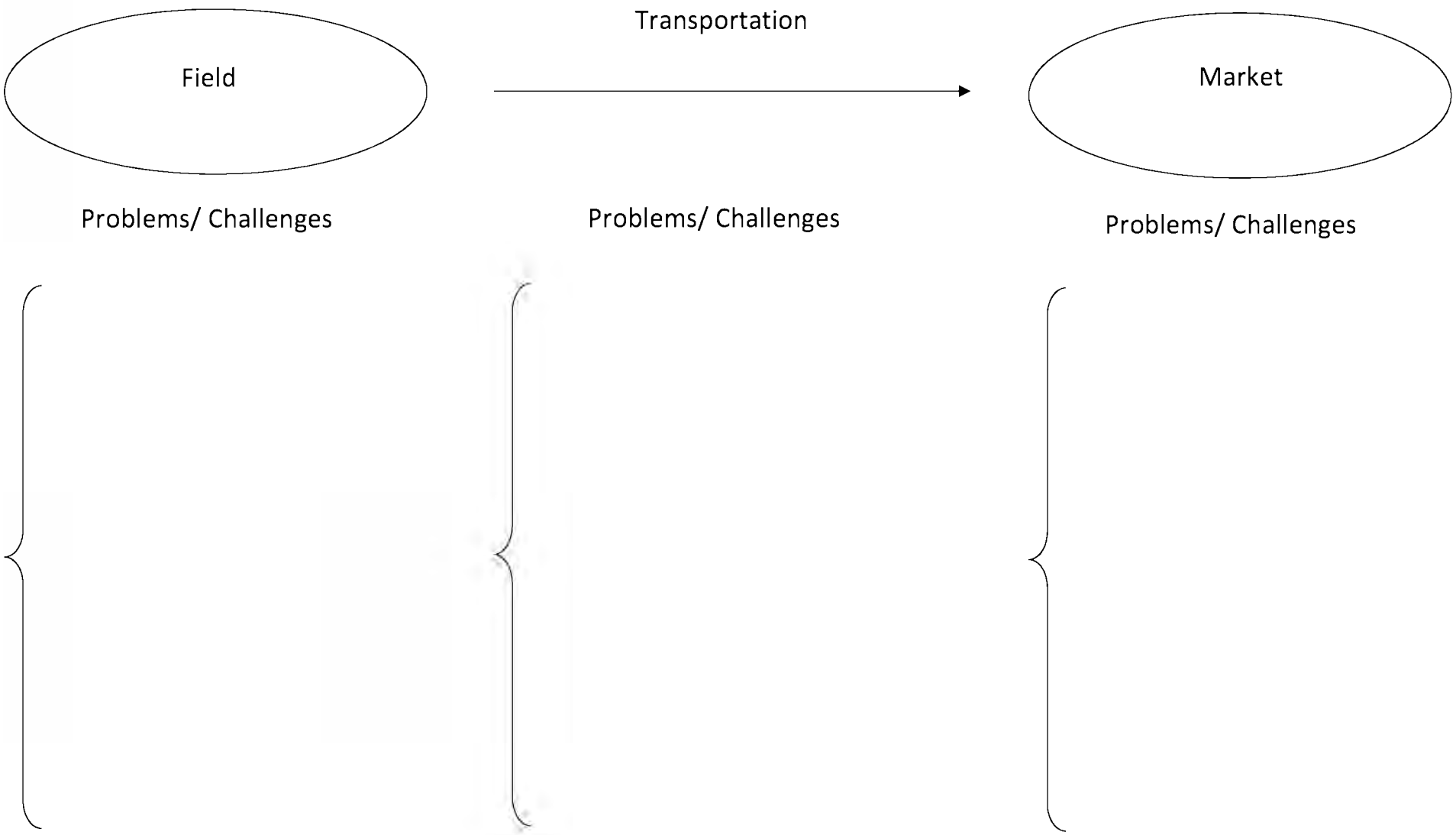
Farming Plan for 2nd Target Crop

Date Irrigation Scheme Name: Crop Name:

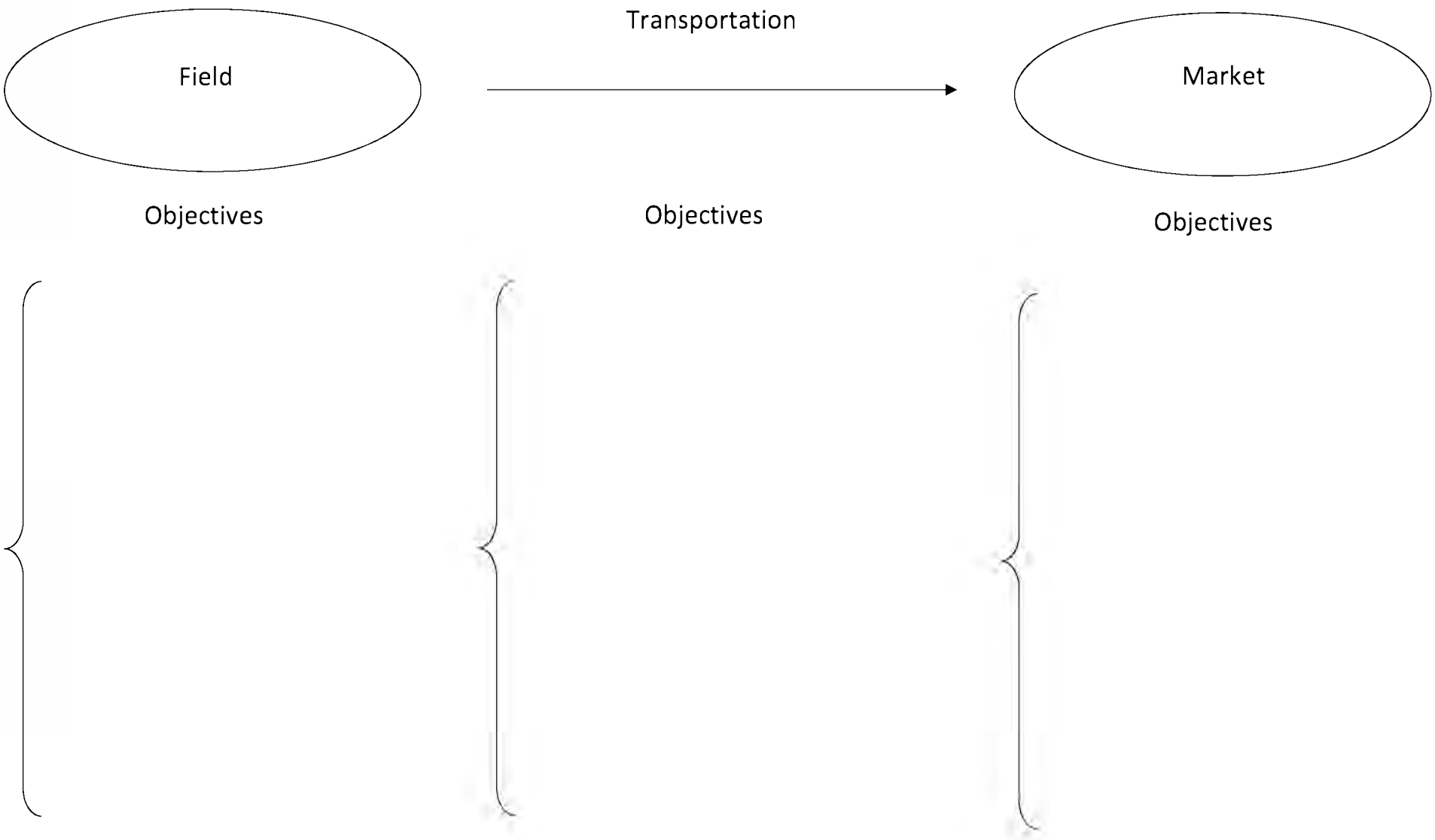
Camp Name: District Name: Province Name:

	Month															
	Week	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Purchase of Inputs																
2	Land Preparation																
3	Nursery Sowing																
4	Transplanting																
5	Top Dressing Fertilizer Application																
6	Pest Disease Control																
7	Weeding																
8	Harvesting																
9	Marketing																
10																	

Problem Map


Transportation
Field
Market
Problems/ Challenges
Problems/ Challenges
Problems/ Challenges

Objective Map



Action Plan

Date Irrigation Scheme Name:
Camp Name: District Name: Province Name:

Objective	Activity	Stage	Resources	Implementer	Schedule	Monitoring Person

AP-I-259

Market Survey Questionnaire

Date: Irrigation Scheme Name:

Market Name: Market Location:

Name & Contact of the Dealer	Crop & Variety	Crop's Quality of Market Requirements	Peak Demand (Months)	Quantity (kg) & Frequency (daily/ weekly etc.) of Supply	Place of Production	Purchasing Unit Price (ZK/ kg)	Mode of Payment	Terms of Payment	Marketing Condition	Dealer Willingness to Purchase the Crops from the Group (*)

*(If Yes, How Soon? If no, give reasons.)

AP-11260

No_____.

CROP PRODUCTION & INCOME ANALYSIS DATA (CP&IAD) SHEET

Irrigation Scheme Name: _____ Camp: _____ District: _____ Province:_____ Survey Date: _____.

Farmer's Name: _____ Male/Female: _____ Mobile No.: _____ CEO's Name: _____.

Area of the Field: ____m by ____m or ____ lima (irrigated) / Area of the Field: ____m by ____m or ____ lima (rain-fed)

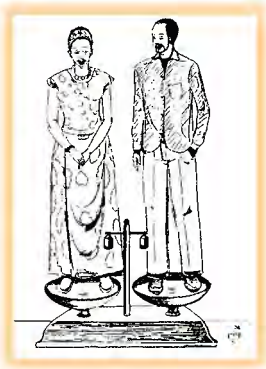
(1) Crop Name and Variety/ Selected by Market Survey (Y / N)	(2) Cultivation Period	(3) Area under the Crop (M x M or Lima)		(4) Total Production (Kg)	(5) Total Production per Lima (Kg/Lima)	(6) Home Consumption Amount (kg)	(7) Damage and Loss Amount (kg)	(8) Sold Amount (Kg)	(9) Total Income (ZK)	(10) Type of Market to Sell*1		(11) Average Price per Kg (ZK./kg)	(12) Cost of Inputs (seeds, fertilizer, chemicals) (ZK)	(13) Cost of Labour Hired for Cultivation (ZK)	(14) Cost of Transport to Market(ZK)	(15) Total Production Cost (ZK)	(16) Net Income (ZK)
		M X M (M^2)	Lima		(4) ÷ (3)					Cat.	Kg	(9) ÷ (8)				(12)+(13)+(14)	(9) - (15)
I. Irrigated Cultivation																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
II. Rein-fed Cultivation																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	
Market Survey (Y / N)																	

*: 1: sold mostly within the village, 2: sold mostly at nearby towns (not within the village), 3: sold to middlemen who came to the village, 4: others (specify in the remarks below)

Remarks:

AP-11-261

Module-8:
Gender Mainstreaming in Irrigation Farming



1

Training Contents

Section-1: Introduction -Brain Storming-
Section-2: Roles of Female and Male
- Exercise-1: Roles in Daily Life
  Let's review the role of female and male in everyday life! Are those roles sharing comfortable for you?
- Exercise-2: Daily Activity Calendar
  Is there any house works that female (wife) and (husband) help each other?
- Exercise-3: Roles in Irrigation Farming
  Let's think about what can draw the ability of the female to the maximum in irrigation farming!

Section-3: Way forward to A Better Irrigation Farming
-Action Plan Making-
- Exercise-4: Action Plan Format

Remarks

2

AP-I-262

Section-1 : Introduction

Gender Mainstreaming in T-COBSI

- The purpose of Gender Mainstreaming in T-COBSI is to increase production and income brought by irrigation farming through fostering mutual understanding between female and male farmers.
- Gender Mainstreaming of T-COBSI doesn't pursue an ideological thing or a conceptual thing, it is a practical and useful tool for T-COBSI farmers.

3

Q1: Why is Gender Mainstreaming necessary in irrigation farming?

Because....

- Female farmers have a potential to play a big role in irrigation farming as same as male farmer,
- So that Female farmers can be a part of major contributor to the irrigation farming as same as male farmer,
- However, there is tendency that some female farmers are at position away from resource control (e.g. land, house budget), decision making (e.g. way to use the house budget) etc. and bearing more workloads than male,
- From another aspect, female headed families constitute a big number, especially in the rural area

In order to eliminate or lessen various problems/issues resulting from these facts, T-COBSI introduces the idea of Gender Mainstreaming as a tool to practice a better irrigation farming while considering different roles, perceptions, needs etc. between female and males farmers.

4

Q2: Is Gender Mainstreaming only for Female?

A: No!, it is because that;

- Enhancement of mutual understanding and better communication between female and male can result in;
- At household level: cooperative house works which can motivate/encourage wives (=female farmers) into farming activity,
- At farming level: collaborative irrigation farming which can bring more production to household,
- However, it is not to come true even if there is not either female and male,

So, equal development to both female and male is indispensable to improve the farmers (the household) livelihood through practicing Gender Mainstreaming in irrigation farming.

Q3: What are Difference between Gender & Sex

- Gender and sex are two different concepts with different meanings

SEX	GENDER
Biologically determined	Constructed by society
Universal for all human beings	Multi-faceted differs within culture and/or between culture
Unchanging	Dynamic, changes over time
In born	Acquired

Q4: What is "Gender" ?

- Gender refers to complementarities and collaboration of female and male based on the improved mentality,

that gives everybody the same right and opportunities in all aspects of life without favoring any sex,

- Gender does not refer to female sex as some people wrongly think.

Section-2 : Roles of Female & Male

- This section discusses "Role Sharing between female and male" in farmers' daily life and in irrigation farming by conducting a series of exercises,

We'll see;

- Are there any roles which female and male can help each other?,
- Are there any constraints that make female farmers (wives) discourage to be involved in irrigation farming?,
- How can maximize female's performance in irrigation farming?
- Etc. etc.

Exercise-1: Who's Role in Daily Life? Female or Male?

Roles	More depending on Female	Evenly	More depending on Male	Gap of perception between Female and Male
Water fetching for domestic use				
Firewood collection				
Feeding livestock				
Cooking				
Washing dishes				
Washing clothes				
Taking care of babies				
Taking care of Grandpa, Grandma				
Speaking in public(village meeting etc.)				
Taking initiatives in any organizations				
Controlling household budget				
Any other roles				

Remarks:

1st: Answers are given by female group and male group respectively.

2nd: After answering from both group, the gap of perception between female and male is to be compared.

3rd: Discussing whether these roles are shared properly or not, or if females and males are comfortable with these role sharing or not, etc.

9

AP-I-I-264

Exsersise-2: Daily Activity Calendar

- Purpose of the Excersise-2 is to understand who bears "Productive Works" and "Reproductive Labors" in farmers' daily life,
- "Productive works" can be translated as "Works which create more benefit", they can be evaluated with money, e.g. farming, casual labor etc.
- "Reproductive Labors" can be said as "Domestic works" in other word, which are understood as house works such as cooking, washing, cleaning house, etc. Those works are not paid, they are very important works though.
- After answering, start discussing if there are some "Reproductive Labors" which can be done by both female (wife) and male (husband) cooperatively in order to motivate/encourage female (wife) more into farming activity.

Exsersise-2: Daily Activity Calendar

"Productive Works" & "Reproductive Works"

Time	AM							
	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
Female's role								
Male's role								

Time	PM										
	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Female's role											
Male's role											

Exsersise-2: Daily Activity Calendar

Time	AM							
	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
Female's role								
Male's role								

Remarks:

1st: Answers are given by female group and male group together, and put "Pro" or "Repro" on each role.

2nd: After identifying "P" or "R", start discussing if there are any house works that female (wife) and male (husband) help each other (= e.g. Can male bear more "R" for female?) to make female motivate/encourage more into (irrigation) farming.

Time											
	13:00										:00
Female's role											
Male's role											

Exercise-3:
Who's Role in Irrigation Farming? Female or Male?

Roles	More depending on Female	Evenly	More depending on Male	Gap of perception between Female and Male
Land preparation (Ridging etc.)				
Sowing				
Weeding				
Watering				
Fertilizer/Chemical application				
Water Sharing Management				
Harvesting				
Controlling (decision making) production selling				
Irrigation facilities maintenance such as desilting, mending, grass clearing, etc.				
Any other role				
Any other role				

Remarks:

1st: Answers are given by female group and male group respectively.

2nd: After answering from both group, the gap of perception between female and male is to be compared.

3rd: Discussing whether this role sharing is appropriate to increase the production as well as income. How can draw the ability of the female farmer to the maximum in irrigation farming?

Exsersise-4: Action Plan Format

Items are same to Action Plan of Marketing

Problem /issues Identified from Excesses	Objective to achieve	Activity	Stage	Resources	Implement er	Schedule	Monitoring Persons

Section-3 : Way forward to A Better Irrigation Farming -Action Plan Making-

- Activity of this section is to make Gender Mainstreaming Action Plan based on the result of exercise and discussion done so far, namely, "Roles in Daily Life", "Daily Activity Calendar", and "Roles in Irrigation Farming",
- Farmers use this action plan as a tool to increase production and income from irrigation farming from gender aspect,
- Acton Plan is formulated with "SMART" method : Specific, Measurable, Attainable, Realistic and Time-limited

Remarks

Things to Keep in Mind for T-COBSI Gender Training

- Let's invite couples in the targeted irrigation scheme as many as possible to share same information (same training) resulting in activation of their conversation and collaboration,
- since there may be some female farmers (wives) who cannot express their opinion honestly in front of male members,
- even there may Some of male farmers may show their uncomfortable/negative to gender talking, since they think gender give disadvantage to male.

Tatotera Mkwai

Practice:
Who dose control resources? Female or Mala?

Resources	Female	Male
Land		
Cash		
House/Buildings		
Food		
Fertilizers/Chemicals		
Faming tools/machines		
Bicycle		
Livestock		

CONTENTS OF SURVEY ON THE EXISTING SIMPLE IRRIGATION SCHEMES

SURVEY ON THE EXISTING SIMPLE IRRIGATION SCHEMES

1.1 OUTLINE OF THE SURVEY

1.1.1 Objective of the Survey

During the pilot project of the COBSI Study (2009-2011), more than 550 simple-weir irrigation schemes and 8 permanent-weir irrigation schemes had been constructed. The follow-up survey is to investigate the current situation of these irrigation schemes so as to obtain the baseline indices of the schemes for further development; understand the impact of the COBSI approach; draw practical lessons in smallholder irrigation development.

In particular, questionnaire survey was conducted, covering the physical condition of the irrigation facilities, condition in operation and maintenance (O&M), institutional arrangement, farming systems, and marketing. This section of the report discusses the findings from the questionnaire survey collected and encoded by the early February 2014. Note that the dataset is still provisional and it will be finalized by the next progress report to be compiled in August 2014.

1.1.2 Procedure of the Survey

The follow-up survey was conducted using a pre-determined questionnaire form. Firstly, draft questionnaire was prepared by the expert team and revised through a series of discussions among the members of the PIU Northern province. After the pretests in three schemes, then, the questionnaire was finalized.

Originally, it was planned to conduct the survey by a group of surveyors hired from outside. However, PIU members suggested doing the survey by making the best use of the ministry's administrative structure—the existing extension structure. Accordingly, the survey was done by the extension officers as a part of the on-the-job training in social research. Particularly, copies of questionnaires had been distributed through such a channel: PIU—district TSB officer—extension officers.

Table 1.1.1 Number of Questionnaires Collected by District

No.	District	Target No. of Sites※1 (A)	Questionnaires Collected (B)	Collection Rate※2 (C=B/A)	To be Collected (Confirmed)	Data Input Completed*3 (D)	Input Rate (E=D/B)
Northern							
1	Kasama	25	23	92%	0	23	100%
2	Luwingu	49	42	86%	0	42	100%
3	Mbala	84	62	74%	22	34	55%
4	Mporokoso	63	46	73%	0	25	54%
5	Mungwi	61	56	92%	0	56	100%
Total		282	229	81%	22	180	79%
Muchinga							
6	Isoka	16	16	100%	0	15	94%
7	Mpika	60	62	103%	0	57	92%
8	Nakonde	36	36	100%	0	36	100%
Total		112	114	102%	0	108	95%
Luapula							
9	Kawambwa	38	32	84%	0	32	100%
10	Mansa	80	57	71%	15	57	100%
11	Milenge	10	5	50%	0	5	100%
12	Mwense	35	32	91%	0	32	100%
13	Nchelenge	8	9	113%	0	9	100%
Total		171	135	79%	15	135	100%
Grand Total		**565**	**478**	**85%**	**37**	**423**	**88%**

Source : Source: JICA T-COBSI Project Team (as of February 2014)

*1 : Anticipated based on the outcomes of the Pilot Project of the COBSI Study.

*2 : There are some sites constructed after the Pilot Project of the COBSI Study, leading to the collection rate more than 100%.

*3 : It shows the number of data input by early Feb 2014, which are applied in this report

: For the questions regarding "institutions," "gender" and "operation and maintenance", data encoding was completed only for 413 sites.

In so doing, JICA supported the transportation cost for the distribution as well as for conducting the

survey. Then, filled questionnaires had been sent back to the PIU Northern province for encoding. Table 1.1.1 shows the number of questionnaires collected by the early February 2014, which was used for the analysis in this report. Note that the questionnaires are still being collected and encoded and thus the findings in this report are still provisional.

1.1.3 The Dataset

By the beginning of February 2014, data for a total of 423 sites have been encoded, which covers a total of 133 camps in the 13 districts of the target area. As far as the number of sites is concerned, there are relatively a large number in Mansa (57), Mpika (57), and Mungwi (56), while relatively less numbers of sites are performed in Milenge (5), and Nchelenge (9). These two districts having less number have been actually ranked least in terms of the irrigation potential during the COBSI Study. In this section, a series of analysis have been made based on the dataset collected and encoded as shown below.

Table 1.1.2 Number of Data Analyzed

Province	District	No. of Camps	No. of Schemes	Portion
Northern	Kasama	13	23	5%
	Luwingu	5	42	10%
	Mbala	7	34	8%
	Mporokoso	9	25	6%
	Mungwi	16	56	13%
Muchinga	Isoka	5	15	4%
	Mpika	12	57	13%
	Nakonde	9	36	9%
Luapula	Kawambwa	11	32	8%
	Mansa	25	57	13%
	Milenge	3	5	1%
	Mwense	11	32	8%
	Nchelenge	7	9	2%
Total	**Total**	**133**	**423**	100%

Source: JICA T-COBSI Project Team (as of February 2014)

Nonetheless, the number of data encoded did not reach 423 for three sections: institution, operation and management, and gender, for which the number of data encoded was 413 sites. Also, the number of valid responses varies according to each question as there are a number of blanks and incomplete answers disregarded.

1.2 GENERAL CONDITION

1.2.1 Number of Beneficiaries

Capturing demographic information of irrigation schemes is quite challenging, farmers do not necessarily keep the record of all the beneficial members nor have common understanding in the definition of household. As a result, it was sometimes quite difficult to draw realistic figures especially for the number of beneficiaries per sites. In this context, the result of the survey on the number of households and beneficiaries is introduced hereunder.

1) Average Number of Beneficial Households and Individuals (Initial vs. Present)

Table 1.2.1 summarizes an average number of households by district in comparison between initial and present. As shown in the table, as of the total of 423 valid responses, the number of household per site is 25 households at the time when schemes were newly developed/improved, which has increased to 35 households/sites by today. This tendency is common in most of the districts. In terms of the number of beneficiaries per site, an average was initially 122, which has increased to 176: an increment of 54 beneficiaries on average.

Table 1.2.1 Average Number of Households and Beneficiaries (Initial vs. Present)

District	No. of Sites	No. of Households per Site			No. of Beneficiaries per Site		
		Initial	Present	Increase	Initial	Present	Increase
Kasama	23	56	87	31	166	303	137
Luwingu	42	14	25	11	55	114	59
Mbala	34	20	25	5	93	92	-1
Mporokoso	25	17	25	8	65	107	42
Mungwi	56	28	38	11	147	252	105
Isoka	15	13	20	7	70	118	48
Mpika	57	36	44	7	189	233	44
Nakonde	36	8	8	0	37	37	1
Kawambwa	32	24	43	18	139	233	93
Mansa	57	22	27	6	127	178	50
Milenge	5	11	21	10	45	59	13
Mwense	32	20	29	9	109	150	41
Nchelenge	9	75	92	17	387	422	35
Average/Total	423	25	35	10	122	176	54

Source: JICA T-COBSI Project Team (as of February 2014)

2) Average Number of Beneficiaries by Women and Men (Initial vs. Present)

Looking at the shift in gender balance in the irrigation schemes, there is not much change observed: proportion between women and men at the initial stage was 55:45, which has remained the same 55:45 by today (shown in the right columns in Table 1.2.2). Specifically, both women and men have increased their numbers in the schemes. On average, women has increased from 67 to 97 (an increment of 30) and men has increased from 55 to 79 (an increment of 24). Thus, as far as the number is concerned, both women and men beneficiaries have an increasing tendency.

Table 1.2.2 Average Number of Beneficiaries by Women and Men (Initial vs. Present)

District	No. of Women Beneficiaries per Site			No. of Men Beneficiaries per Site			Initial		Present	
	Initial	Present	Increase	Initial	Present	Increase	Women	Men	Women	Men
Kasama	91	177	86	75	126	51	55%	45%	58%	42%
Luwingu	29	65	36	26	48	23	53%	47%	57%	43%
Mbala	48	48	0	45	44	-1	52%	48%	53%	47%
Mporokoso	30	49	19	35	59	24	46%	54%	45%	55%
Mungwi	79	135	56	67	117	49	54%	46%	54%	46%
Isoka	36	61	25	34	56	23	52%	48%	52%	48%
Mpika	108	131	22	81	102	21	57%	43%	56%	44%
Nakonde	19	19	0	18	18	0	51%	49%	51%	49%
Kawambwa	77	124	46	62	109	47	56%	44%	53%	47%
Mansa	67	97	30	60	80	20	53%	47%	55%	45%
Milenge	27	35	8	18	24	5	60%	40%	59%	41%
Mwense	59	80	21	50	70	20	54%	46%	54%	46%
Nchelenge	246	256	10	141	166	25	64%	36%	61%	39%
Average	67	97	30	55	79	24	55%	45%	55%	45%

Source: JICA T-COBSI Project Team (as of February 2014)

1.2.2 Quantity of Water Flow during Dry Season

Based on the information on the depth, width and the velocity of the stream, expected quantity of water flow during dry season is estimated using a formula: Q=W x D x 0.7, where Q = quantity, W = width of the stream, D = depth of the stream, and 0.7 is an adjustment factor set based on the dimension and an average velocity of stream. The result of the estimation is summarized in Table 1.2.3. It turned out that majority (44%) of the sites have water flow 0.5 m^3/s or more, which is followed by 0.20-0.50 m^3/s (36%). This volume can be converted to a potential area as indicated in the remark, e.g., 0.20 m^3/s can irrigate approximately 100 ha. Thus, concerning the average size of irrigated area per site, majority of sites should have enough water potential, although the estimation is still rough.

Table 1.2.3 Quantity of Water during Dry Season

Water Flow	No. of Sites	%	Average	Remark
<0.02	2	1%	0.02	<10 ha
0.02-0.04	2	1%	0.04	10-20 ha
0.04-0.10	17	6%	0.07	20-50 ha
0.10-0.20	38	13%	0.16	50-100 ha
0.20-0.50	109	36%	0.38	100-250 ha
>0.50	134	44%	5.99	>250 ha
Total/ Average	**302**	**100%**	**2.82**	_

Source: JICA T-COBSI Project Team (Feb 2014); Note: Based on an open-ended question.

1.2.3 Irrigated Area

Based on the result of the questionnaire survey, it turned out that the area irrigated (1.4 ha/site) is much bigger than what was reported in the pilot project of the COBSI Study (approximately 1.0 ha/site). If it can be applied, a total irrigated area of whole target area is to be: 1.4 ha/site X 515 sites (478 collected +37 to be collected) = 721 ha at initial time and 1.9 ha/site X 515 sites =979 ha at present. The detailed figure will be assessed after all the data inputting is completed.

As a general picture, Table 1.2.4 shows the number of sites by the change in the irrigated area. Irrigated area is somehow increased at 63% of the sites, while it decreased in 24% of the sites. Interestingly, no change is reported for only 13% of the sites. Note that there are eight sites where irrigated area became zero, implying some difficulty in securing water.

Table 1.2.4 Number of Sites by Change in the Irrigated Area

Area Irrigated	No. of Sites	%
Increase	266	63%
Decrease	102	24%
(abandoned)	(8)	(2%)
No Change	55	13%
Total	423	100%

Source: JICA T-COBSI Project Team (as of February 2014)

As shown in Table 1.2.5 below, most of districts, except for Luwingu and Muwense where the area has remained the same, have experienced an increase in the irrigated area: on average 0.5 ha/site, ranging from 0.2 ha to 1.3 ha. Furthermore, potential area is estimated on average 9.4 ha/site, of which only 20% is already developed. Note that however, estimation of potential area is not an easy task for extension officers, and therefore the use of this figure should be limited only as a reference.

Table 1.2.5 Change in the Area irrigated (Initial to Present)

District	Irrigated Area (ha)			Potential (ha)	Use Rate
	Initial	Present	Increase		
Kasama	2.4	2.9	0.6	12.7	23%
Luwingu	1.4	1.4	0.0	7.8	18%
Mbala	1.3	2.1	0.9	8.3	26%
Mporokoso	1.0	1.5	0.5	2.6	58%
Mungwi	2.0	2.3	0.4	22.8	10%
Isoka	1.4	2.8	1.3	6.5	42%
Mpika	2.2	2.4	0.2	13.1	18%
Nakonde	0.7	0.9	0.2	2.2	40%
Kawambwa	0.8	1.9	1.1	4.2	44%
Mansa	0.9	1.5	0.6	5.1	29%
Milenge	0.1	0.9	0.8	7.3	12%
Mwense	1.3	1.3	0.0	9.7	14%
Nchelenge	1.2	1.8	0.6	7.6	23%
Average	1.4	1.9	0.5	9.4	20%

Source: JICA T-COBSI Project Team (as of February 2014)
Note: Extreme figures are adjusted by the Project Team, i.e. those with more than 5ha are adjusted to 5 ha.

In addition, Table 1.2.6 summarizes the number of sites by the scale of irrigated area per site. As shown in the table, 46% of the sites are categorized within a range up to 1.0 ha/site (inclusive of 1.0ha/site) and moreover 67% of the sites are up to 2.0 ha/site. On the other hand, there are another

group wherein irrigated area is more than 4.0 ha, sharing 16% of the total number of sites. It needs to be clarified whether these figures are overestimation or exceptionally successful area blessed by preferable water resources and topography.

Table 1.2.6 Number of Site by the Scale of Irrigated Area per Site

Present Area Irrigated	No. of Sites	%	Average (ha)
Up to 0.5 ha	96	23%	0.3
0.5-1.0 ha	95	23%	0.9
1.0-2.0 ha	87	21%	1.6
2.0-3.0 ha	47	11%	2.7
3.0-4.0 ha	21	5%	3.6
More than 4.0 ha	66	16%	5.0
Total/ Ave	412	100%	1.9

Source: JICA T-COBSI Project Team (as of February 2014)
Note: Extreme figures (more than 5 ha) are adjusted by the Project Team

1.2.4 Water Potential vs. Irrigated Area

Table 1.2.7 compares the expected water potential and the area currently under irrigation, which is to evaluate the current area against potential area to know if the further development is possible or not in terms of water potential. As shown in the table where water potential is shown on the rows as a value in hectare and the current irrigated area is shown on the columns, 98% of the sites still have more potential to develop. As far as the quantity of water at the diversion point is concerned, many sites have potential to further develop their irrigated area.

It should be noted, however, that there are a number of sites claiming water shortage especially at the end of dry season. Also, as discussed in 1.3.2, 13% of the sites have decreased the length of furrow, implying a lack of water in these sites. Thus, aside from the high potential in quantity of water, loss of water during the conveyance should be also considered.

Table 1.2.7 Comparison between Water Potential and Current Area Irrigated

Item		Present Irrigated Area						
		<10 ha	10-20 ha	20-50 ha	50-100 ha	100-250 ha	300 ha	Total
Potential	<10 ha	1						1
	10-20 ha	2						2
	20-50 ha	11	4	1				16
	50-100 ha	26	4	3	1	2		36
	100-250 ha	87	6	9	3			105
	>250 ha	92	18	13	5		1	129
	Total	219	32	26	9	2	1	289
No More Area to Dev.		1	0	1	1	2	1	6
More Area to Dev.		218	32	25	8	0	-	283
%		100%	100%	96%	89%	0%	-	98%

Source: JICA T-COBSI Project Team (Feb 2014); Note: Based on an open-ended question.

1.2.5 Water Use of the River/Stream

Water use of river/ stream that the scheme is taking water from is addressed using pre-determined 8 choices as shown in Table 1.2.8, for three locations: in the scheme, upstream, and downstream. In the scheme, 400 out of a total of 423 sites use water for irrigation. There are several possible reasons why it did not reach 100%: data incomplete, the scheme is no longer functional, diverted water is used only for other purposes. Then, next popular use is "drinking" given 81%, which is followed by washing clothes (79%), washing dishes (77%) and cooking (75%).

It is also addressed upstream and downstream, although reliability of data might go down as it is information of other area. In upstream area, on average 2.3 km away from the scheme, the most common use of water is irrigation (75%), which is followed by drinking (71%). Similar tendency is found in downstream area (on average, 2.3 km away from the scheme). Thus, it can be said that, in many sites, water in the river/stream is also used by other communities both upstream and downstream,

implying a necessity of coordination among these communities before and after the construction of the irrigation weirs.

Table 1.2.8 Water Use of the River/Stream (In the Scheme, Upstream and Downstream)

Water Use of River/Stream	In the Scheme		Upstream		Downstream	
	No. of Sites	%	No. of Sites	%	No. of Sites	%
Irrigation	400	95%	318	75%	336	79%
Drinking	344	81%	301	71%	302	71%
Cooking	319	75%	264	62%	276	65%
Washing Dishes	326	77%	257	61%	291	69%
Washing Clothes	333	79%	266	63%	310	73%
Fish Pond	224	53%	136	32%	159	38%
Cattle	120	28%	85	20%	98	23%
Others	91	22%	70	17%	62	15%
Total Number of Sites	423	100%	423	100%	423	100%
Distance from the Scheme (km)	--		2.30		2.31	

Source: JICA T-COBSI Project Team (Feb 2014).
Note: Number for the "irrigation" in the scheme did not reach 100%, maybe, attributing to some missing data and the use of diverted water for other purposes.

1.3 IRRIGATION FACILITIES

1.3.1 Weirs

1) Types of Weirs

There are four major types of weirs introduced through the pilot project of the COBSI Study: single-line, double-line, inclined, and trigonal-prop weirs (see Figure 1.3.1).

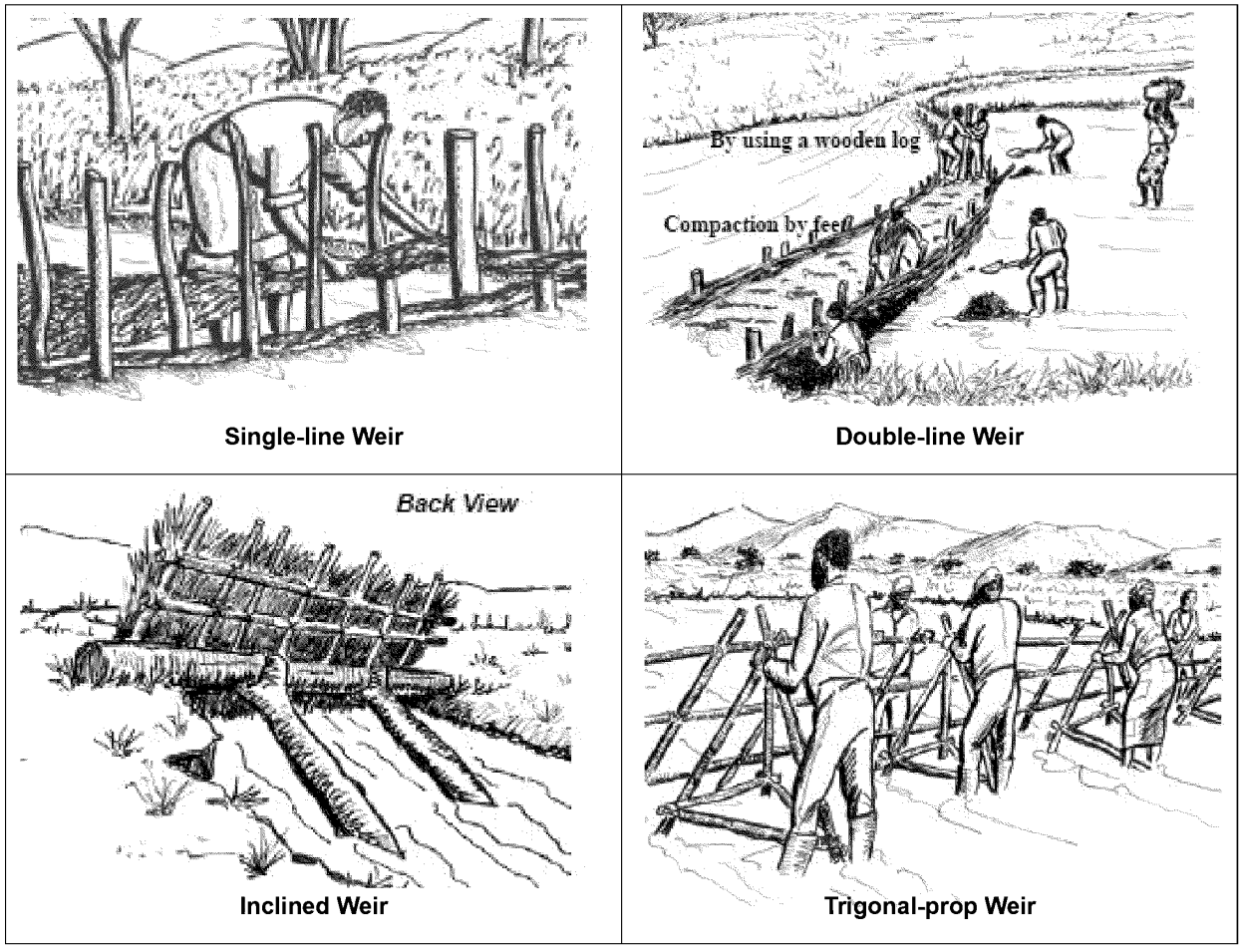


Figure 1.3.1 Four Types of Simple Weirs Disseminated in the COBSI Study
Source: JICA T-COBSI Project Team

Single line is applicable with a soft foundation and the water flow is minimal, while double-line is suitable to similar sites with faster water flow as it is more stable. On the other hand, inclined type is applicable to such conditions where foundation of the river is hard and width of the river is narrow so that a log can put across the river. Trigonal-prop type is structurally a bit more sophisticated than others but applicable to any sites even where other weir types are not suitable.

Now, Table 1.3.1 summarizes the number of sites categorized by the type of weir by district. As shown in the table, single-line shares 68% of the total valid responses (number of sites), which is followed by double-line type (13%). It is assumed that these types are technically easy to construct for farmers in many sites and these sites are blessed with a soft foundation near *dambo* areas. It should be also noted that trigonao-prop type was also applied in a total of 18 sites, 2 in Norhtern, 9 in Muchinga, and 7 in Luapula provinces—suggesting a good applicability of this technology attributing to the effectiveness of the trainings and the manuals distributed.

Table 1.3.1 Number of Sites by the Type of Weirs

Province	District	Single-line	Double-line	Inclined	Trigonal	Others	Total	% by District
Northern	Kasama	12	1	1	0	1	15	4%
	Luwingu	28	2	2	1	6	39	11%
	Mbala	18	0	7	0	4	29	8%
	Mporokoso	15	6	1	0	0	22	6%
	Mungwi	31	5	9	1	1	47	13%
	Total	**104**	**14**	**20**	**2**	**12**	**152**	**42%**
Muchinga	Isoka	2	7	2	4	0	15	4%
	Mpika	44	5	2	5	1	57	16%
	Nakonde	25	1	0	0	3	29	8%
	Total	**71**	**13**	**4**	**9**	**4**	**101**	**28%**
Luapula	Kawambwa	18	0	3	3	1	25	7%
	Mansa	23	17	4	0	1	45	12%
	Milenge	7	0	2	0	3	12	3%
	Mwense	15	2	0	4	0	21	6%
	Nchelenge	9	0	0	0	0	9	2%
	Total	**72**	**19**	**9**	**7**	**5**	**112**	**31%**
Grand Total		**247**	**46**	**33**	**18**	**21**	**365**	**100%**
Share (%)		**68%**	**13%**	**9%**	**5%**	**6%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)
Note: "Others" includes the use of spring water, earth dam, and permanent weir.

2) Dimensions of Weirs

In this section, typical sizes of the weirs are discussed. Frist, Table 1.3.2 summarizes the number of sites by the length of weir with a total of 258 valid responses. Number of sites is nearly equally distributed within three categories: 1-3m (29%), 3-5m (29%), and 5-10m (33%), implying quite a good variation of the river width from 1m up to 10 m. Probably, it is difficult to construct simple weir on the river more than 10 m in width. Looking at an average length of the weir, it reaches 10.1 m as a result of some weirs more than 10 m in length.

Table 1.3.2 Number of Sites by Length of Weir

Province	District	Length of Weir						Average (m)
		0-1m	1-3m	3-5m	5-10m	>10m	Total	
Northern	Kasama	0	7	2	2	1	12	13.3
	Luwingu	3	13	6	9	1	32	6.5
	Mbala	3	10	5	5	1	24	4.0
	Mporokoso	0	6	2	2	1	11	14.9
	Mungwi	0	5	11	14	1	31	9.9
	Total	**6**	**41**	**26**	**32**	**5**	**110**	**8.9**
Muchinga	Isoka	0	1	2	5	1	9	10.7
	Mpika	0	11	12	18	1	42	7.3
	Nakonde	0	9	11	5	1	26	5.4
	Total	**0**	**21**	**25**	**28**	**3**	**77**	**7.3**
Luapula	Kawambwa	1	3	10	8	1	23	9.0
	Mansa	1	1	4	13	1	20	23.4
	Milenge	1	4	2	1	1	9	6.8

Province	District	Length of Weir						Average (m)
		0-1m	1-3m	3-5m	5-10m	>10m	Total	
	Mwense	2	4	10	7	0	23	4.9
	Nchelenge	0	4	2	0	1	7	12.1
	Total	**5**	**16**	**28**	**29**	**4**	**82**	**14.0**
Grand Total		**11**	**78**	**79**	**89**	**12**	**269**	**10.1**
Share (%)		**4%**	**29%**	**29%**	**33%**	**4%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

Similarly, number of sites is summarized in Table 1.3.3 by the width of weir. As shown in the table, the most common height of the weir is 1.0-1.5 m sharing 32% of the total number of valid responses, which is followed by 0.5-1.0 m (30%) and 1.5-2.0 m (21%). Although it was not recommended with a safety reason, there reported are 11 sites with the height more than 2.0 m. The average height is 1.8 m.

Table 1.3.3 Number of Sites by Width of Weir

Province	District	Height of Weir						Average (m)
		0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	
Northern	Kasama	2	4	4	7	0	17	1.4
	Luwingu	13	13	10	1	1	38	0.9
	Mbala	5	7	5	4	1	22	2.4
	Mporokoso	0	6	6	2	1	15	1.6
	Mungwi	2	11	12	10	1	36	2.0
	Total	**22**	**41**	**37**	**24**	**4**	**128**	**1.7**
Muchinga	Isoka	2	7	3	2	1	15	5.0
	Mpika	6	17	16	11	1	51	1.3
	Nakonde	0	5	11	7	1	24	1.7
	Total	**8**	**29**	**30**	**20**	**3**	**90**	**2.0**
Luapula	Kawambwa	5	9	2	6	1	23	1.2
	Mansa	1	11	16	8	1	37	2.0
	Milenge	2	1	5	1	0	9	1.1
	Mwense	4	2	10	4	1	21	1.7
	Nchelenge	0	2	2	2	1	7	1.9
	Total	**12**	**25**	**35**	**21**	**4**	**97**	**1.7**
Grand Total		**42**	**95**	**102**	**65**	**11**	**315**	**1.8**
Share (%)		**13%**	**30%**	**32%**	**21%**	**3%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

3) Dimensions of Intake Channels

Dimensions of intake channels are summarized in the tables below: On average of a total of 330 valid responses, width of intake channels resulted as 1.5 m. The most common size is in between 0.5-1.0 m in width, sharing 39% of all. There are also some sites having more than 2.0 m in width.

Table 1.3.4 Number of Sites by Width of Intake Channel

Province	District	Width of Intake Channel						Average (m)
		0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	
Northern	Kasama	2	6	4	3	2	17	1.6
	Luwingu	3	16	5	9	1	34	1.3
	Mbala	4	8	8	3	1	24	1.2
	Mporokoso	0	5	2	3	6	16	2.0
	Mungwi	5	11	4	6	12	38	2.1
	Total	**14**	**46**	**23**	**24**	**22**	**129**	**1.6**
Muchinga	Isoka	3	6	5	0	0	14	0.9
	Mpika	2	26	9	5	12	54	1.6
	Nakonde	11	8	0	0	6	25	1.4
	Total	**16**	**40**	**14**	**5**	**18**	**93**	**1.4**
Luapula	Kawambwa	3	9	2	6	5	25	1.9
	Mansa	18	12	2	7	5	44	1.2
	Milenge	1	8	0	0	0	9	0.8
	Mwense	1	9	0	3	8	21	1.9
	Nchelenge	0	4	0	3	2	9	1.7
	Total	**23**	**42**	**4**	**19**	**20**	**108**	**1.5**
Grand Total		**53**	**128**	**41**	**48**	**60**	**330**	**1.5**
Share (%)		**16%**	**39%**	**12%**	**15%**	**18%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

As of the depth of intake channels, most common size is 0.5-1.0m, sharing 34% of a total of 302 sites. Also, 23% of the sites have the intake channel more than 2.0 m in depth. Overall average is 0.8 m in depth. It is concluded that there is no critical problems in terms of the dimension of intake channels.

Table 1.3.5 Number of Sites by Depth of Intake Channel

Province	District	Depth of Intake Channel						Average (m)
		0-0.5m	0.5-1.0m	1.0-1.5m	1.5-2.0m	>2.0m	Total	
Northern	Kasama	0	3	5	3	5	16	1.0
	Luwingu	0	16	7	8	3	34	0.7
	Mbala	0	6	4	4	8	22	1.0
	Mporokoso	0	4	4	4	1	13	0.8
	Mungwi	0	7	1	14	11	33	1.0
	Total	**0**	**36**	**21**	**33**	**28**	**118**	**0.9**
Muchinga	Isoka	1	3	6	1	3	14	0.7
	Mpika	1	17	4	18	9	49	0.8
	Nakonde	1	14	0	6	3	24	0.7
	Total	**3**	**34**	**10**	**25**	**15**	**87**	**0.8**
Luapula	Kawambwa	1	8	1	5	7	22	0.9
	Mansa	5	15	3	9	8	40	0.8
	Milenge	1	5	2	0	0	8	0.5
	Mwense	0	1	2	8	8	19	1.1
	Nchelenge	0	5	0	1	2	8	0.9
	Total	**7**	**34**	**8**	**23**	**25**	**97**	**0.9**
Grand Total		**10**	**104**	**39**	**81**	**68**	**302**	**0.8**
Share (%)		**3%**	**34%**	**13%**	**27%**	**23%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

1.3.2 Furrows

1) Dimension of Furrows

This section discusses the typical dimensions of furrows. First, Table 1.3.6 shows the number of sites by the length of furrow at the time when irrigation schemes were developed, while Table 1.3.7 summarizes the same for today. And then, Table 1.3.8 indicates the change from initial to present. In terms of the length of furrows at the time when constructed, an average size was 2.1 km in length, mostly within the range up to 2.0 km (93%). It then reached to 2.4 km by today.

Table 1.3.6 Number of Sites by Length of Furrow (Initial)

Province	District	Length of Furrow (Initial)						Average (km)
		0-0.5 km	0.5-1.0 km	1.0-1.5 km	1.5-2.0 km	>2.0 km	Total	
Northern	Kasama	1	2	5	12	1	21	2.9
	Luwingu	10	12	12	3	3	40	1.7
	Mbala	5	6	8	9	2	30	2.2
	Mporokoso	5	10	7	2	0	24	1.2
	Mungwi	5	12	9	17	6	49	2.8
	Total	**26**	**42**	**41**	**43**	**12**	**164**	**2.2**
Muchinga	Isoka	4	0	1	6	4	15	5.4
	Mpika	8	10	16	19	4	57	2.7
	Nakonde	17	3	9	0	0	29	0.9
	Total	**29**	**13**	**26**	**25**	**8**	**101**	**2.5**
Luapula	Kawambwa	6	6	9	6	0	27	1.7
	Mansa	30	7	6	3	1	47	0.9
	Milenge	5	0	0	1	3	9	2.9
	Mwense	8	10	4	3	3	28	1.8
	Nchelenge	3	1	4	1	0	9	1.2
	Total	**52**	**24**	**23**	**14**	**7**	**120**	**1.5**
Grand Total		**107**	**79**	**90**	**82**	**27**	**385**	**2.1**
Share (%)		**28%**	**21%**	**23%**	**21%**	**7%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.3.7 Number of Sites by Length of Furrow (Present)

Province	District	Length of Furrow (Present)						Average (km)
		0-0.5 km	0.5-1.0 km	1.0-1.5 km	1.5-2.0 km	>2.0 km	Total	
Northern	Kasama	0	2	4	13	2	21	3.6
	Luwingu	2	8	17	11	2	40	2.2
	Mbala	5	1	12	14	1	33	2.3
	Mporokoso	3	8	10	3	0	24	1.5
	Mungwi	4	9	10	15	12	50	3.7
	Total	**14**	**28**	**53**	**56**	**17**	**168**	**2.7**
Muchinga	Isoka	3	0	2	4	6	15	5.7
	Mpika	4	9	16	24	3	56	2.8
	Nakonde	16	3	10	0	0	29	0.9
	Total	**23**	**12**	**28**	**28**	**9**	**100**	**2.7**
Luapula	Kawambwa	6	7	5	5	1	24	1.7
	Mansa	24	8	5	6	1	44	1.2
	Milenge	6	1	0	1	3	11	3.1
	Mwense	8	5	8	2	3	26	1.9
	Nchelenge	3	1	3	2	0	9	1.3
	Total	**47**	**22**	**21**	**16**	**8**	**114**	**1.7**
Grand Total		**84**	**62**	**102**	**100**	**34**	**382**	**2.4**
Share (%)		**22%**	**16%**	**27%**	**26%**	**9%**	**100%**	

Source: JICA T-COBSI Project Team (Feb 2014)

In consideration with the change in the length of furrow, they are divided into three groups: increased, decreased, and no change, which share 43%, 13% and 44% respectively. Within the group of increased sites, the length of furrow increased on an average of 1.2 km, while it decreased 1.7 km within the group of decreased sites. As a result, length of furrow has increased by 0.28 km as the total average.

According to some interviews to the officers on the ground, decrement in the length of furrow mostly attribute to a lack of water caused by seepage at the diversion point and leakage along the furrow. On the other hand, increase in the length of furrow likely to represent the willingness and level of self-help of the farmers in irrigated agriculture. Thus, those sites where the length has increased may have relatively higher potential for upgrading on the social aspect.

Table 1.3.8 Number of Sites by Change in the Length of Furrow from Initial to Present

Province	District	Total Average (km)	Increase		Decrease		No Change	Total No. of Site
			No. of Sites	Ave. (km)	No. of Site	Ave. (km)		
Northern	Kasama	0.65	10	1.7	2	-1.8	9	21
	Luwingu	0.41	21	1.1	2	-3.0	17	40
	Mbala	0.20	22	0.7	3	-3.3	5	30
	Mporokoso	0.29	16	0.6	3	-0.7	5	24
	Mungwi	0.77	24	1.9	5	-1.8	20	49
Muchinga	Isoka	0.35	4	1.3	0		11	15
	Mpika	0.10	20	1.5	7	-3.4	30	57
	Nakonde	0.03	9	0.4	4	-0.7	16	29
Luapula	Kawambwa	-0.13	2	3.8	11	-1.0	14	27
	Mansa	0.31	21	1.2	9	-1.2	17	47
	Milenge	0.38	5	0.8	0		5	10
	Mwense	-0.06	10	0.4	4	-1.5	14	28
	Nchelenge	0.10	1	1.0	1	-0.1	7	9
Total/Average		**0.28**	**165**	**1.2**	**51**	**-1.7**	**170**	**386**
			43%		**13%**		**44%**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

In addition, categorization of irrigation scheme was done in terms of width and depth of furrow (Table 1.3.9). First, majority of the sites have their furrow with 0.5-1.0 in width (52%) and with 0.25-0.50 m in depth (51%), which are about what have been instructed through the pilot project of the COBSI Study. Note that however there are also a number of exceptions like more than 1.5 m in width (4%) or more than 1.0 m in depth (3%). It suggests the necessity of further instruction or trainings about appropriate dimension of furrow. Also, this result will be a good reference when the detailed training is provided during the kick-off training.

Table 1.3.9 Number of Sites by Width and Depth of Furrow

Width of Furrow	No. of Site	%	Average (m)	Depth of Furrow	No. of Site	%	Average (m)
0-0.5m	126	33%	0.44	0-0.25m	38	10%	0.20
0.5-1.0m	199	**52%**	0.84	0.25-0.5m	194	**51%**	0.41
1.0-1.5m	38	10%	1.33	0.5-0.75m	66	17%	0.64
> 1.5m	17	4%	2.02	0.75-1.0m	70	18%	0.94
Total	**380**	**100%**	**0.81**	> 1.0 m	13	3%	1.67
				Total	**381**	**100%**	**0.57**

Source: JICA T-COBSI Project Team (Feb 2014)

2) Condition of Furrows

Table 1.3.10 summarizes the number of sites by condition of furrows evaluated by three categories: good, fair, and poor. As of a total of 398 valid responses (sites), majority, 53% of the total, evaluated the condition of their sites fair. On the other hand, 24% of the sites are regarded as being in a poor condition. Following also address specific issues of furrow condition such as situation of sedimentation, soil erosion, and water leakage.

Table 1.3.10 Number of Sites by Condition of Furrows

Depth of Sediment	No. of Site	%
Good	93	23%
Fair	211	53%
Poor	94	24%
Total	**398**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

3) Depth of Sedimentation

Table 1.3.11 shows the number of sites by depth of sedimentation. As of a total of 327 valid responses, 54% of the sites have 0-10 cm of sedimentation in depth, averaging in 5.27 cm. On the other hand, 21% of the sites have more than 20 cm of sedimentation. As a result, total average of sedimentation reaches 14.27 cm.

Table 1.3.11 Number of Sites by Depth of Sedimentation

Depth of Sediment	No. of Site	%	Average (cm)
0-10cm	177	54%	5.27
10-20cm	84	26%	16.31
20-30m	41	13%	28.83
30-50cm	20	6%	42.65
> 50cm	5	2%	66.00
Total	**327**	**100%**	**14.27**

Source: JICA T-COBSI Project Team (Feb 2014); Note: Based on an open-ended question.

This result will be a good source to formulate an O&M plan wherein how many days of labor works are required in particular site. For example, it requires about 1 person-day to de-silt 10 m of furrow in length which has sedimentation of about 20 cm in depth, or 100 person-days to de-silt for 1 km, provided one person can excavate 2 m^2/ day.

4) Soil Erosion

Table 1.3.12 summarizes the number of irrigation schemes by existing of soil erosion along the furrow. It is found that nearly half (44%) of the sites responded acknowledge some level of soil erosion. As a large number of the sites are located periphery of *dambo* area, the velocity of the stream should not be too fast (see Table 1.3.19 for the analysis on water flow). Thus, this soil erosion might have attributed to an inappropriate dimension of the furrow. More specifically, trapezoidal shape is preferable than rectangle one—this should be also included in the training curriculum in the kick-off training.

Table 1.3.12 Number of Sites by Existence of Soil Erosion

Erosion	No. of Site	%
Yes	168	44%
No	217	56%
Total	**385**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

5) Water Leakage

Frequency of water leakage is summarized in Table 1.3.13 in terms of the number of sites. As shown in the table, 69% of the sites acknowledge the occurrence of water leakage along the furrow. Based on the observation of the field, it is likely attributing to a mouse hole, soil type (sandy), and a lack of compaction. As water leakage is often claimed by farmers, any countermeasures should be introduced in the training, e.g., application of soil cement.

Table 1.3.13 Number of Sites by Water Leakage

Leakage	No. of Site	%
Yes	267	69%
No	119	31%
Total	**386**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

6) Water Quality

Change in water quality sometimes becomes a central issue in irrigation development, affecting the downstream of the scheme or areas within the scheme. Table 1.3.14 shows, however, relatively low percentage of sites that experienced change of water quality (26%). In such areas, type of change needs to be further clarified in the course of the project.

Table 1.3.14 Number of Sites by Change in Water Quality

Change	No. of Site	%
Yes	98	26%
No	282	74%
Total	**380**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

7) Necessity of Rehabilitation

It was asked to the respondent if rehabilitation of the scheme is required. To that question, 93% of the sites have responded it is necessary as shown in Table 1.3.15. Looking at the specific problems they claimed, de-siltation, reconstruction of weir, and repairing of furrow at the point where water is leaking are the major issues—most of the ones should be taken care of by the beneficiaries by themselves.

Table 1.3.15 Number of Sites by Necessity of Rehabilitation

Necessity	No. of Site	%
Yes	348	93%
No	28	7%
Total	**376**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

8) Road Crossing and Gully Crossing

To reach to the farming areas from the diversion point, crossing works are sometimes necessary to be installed, and the failure of installation often hinder the delivery of irrigation water. Now, Table 1.3.16 shows the number of sites that have road crossing and gully crossing. Surprisingly, 153 sites, 40% of the total number of sites have any type of road crossing work and 73 sites 22% of the sites have gully crossing in their sites. Thus, it can be concluded that road crossing and gully crossing can be managed by the community members themselves. To be sure, improved techniques should be introduced in the training (ancillary using wood and/or plastic bags).

Table 1.3.16 Number of Sites by Existence of Road Crossing Works

Exist	Road Crossing		Gully Crossing	
	No. of Site	%	No. of Site	%
Yes	153	40%	73	22%
No	232	60%	257	78%
Total	**385**	**100%**	**330**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014)

1.3.3 Potential for the Upgrading of the Weir

There are multiple factors to identify potential sites for the upgrading of weirs from simple structure to permanent one, which may include slope of river bank, behavior of stream centerline, general river condition, water flow, influence of flood, and foundation. The questionnaire survey has revealed general circumstances of these factors in the irrigation schemes developed in the pilot project of the COBSI Study.

1) Slope of Riverbank

First, the number of sites is summarized by the slope of riverbanks as in Table 1.3.17, indicating the slope of left bank on the rows and the slope of right bank on the columns. As indicated, 140 sites out of a total of 374 sites (37%) maintain the slope of both banks at 0% to 10% (shallow), while only 29 out of 374 (8%) have the slope more than 20% for both banks where the weir is located. This result well reflects the general topography in Northern, Muchinga and Luapula provinces.

As to consider the potential sites for upgrading, however, relatively steep banks are required to stabilize the weir structure, preferably more than 20%. Permanent structure can be constructed even in such a location where the slope is 10%-20% but the length of weir tends to become longer and thus not much cost-effective. As far as the slope of the riverbank is concerned, therefore, there are only 29 sites which can be fully recommended as potential sites

Table 1.3.17 Number of Sites by Slope of Riverbank

Slope		Right Bank				
		0 to 10%	10 to 20%	>20%	Total	
Left Bank	0 to 10%	140	46	4	190	51%
	10 to 20%	27	99	11	137	37%
	> 20%	7	11	29	47	13%
	Total	174	156	44	374	100%
		47%	42%	12%	100%	

Source: JICA T-COBSI Project Team (Feb 2014)

2) River Shape and Stream Centerline

Ideally, permanent weirs need to be placed in such a place where river shape is straight and the streamline never changes (stable). At least such a location should be avoided where streamline tends to move because the river would possibly detour the weir in the future. Table 1.3.18 summarizes both factors in the matrix, implying that 42% of the sites are not recommendable for the construction of permanent weir. On contrary, 56 sites (16%) are best suited to construct the ones.

Table 1.3.18 Number of Sites by Stream Centerline

Item		Streamline Tends to Move			
		Yes	No	Total	
River Shape	Straight	20	**56**	76	21%
	Winding	131	153	284	79%
	Total	151	209	360	100%
		42%	58%	100%	

Source: JICA T-COBSI Project Team (Feb 2014)

3) River Condition and Water Flow

Irrigation schemes are categorized based on the general river condition with three types: *dambo*, flat

land, hilly area, which are also compared with the level of water flow: moderate and rapid. As shown in Table 1.3.19, 47% of the sites are in *dambo* area where permanent weir is not applicable, which is followed by flat land (32%) and then hilly area (21%). As a result, water flow is relatively "moderate" in 83% of the sites. To be safer, potential sites for upgrading should be selected from hilly area.

Table 1.3.19 Number of Sites by River Condition and Water Flow

Item		Water Flow			
		Moderate	Rapid	Total	
Terrain	Dambo	156	20	176	47%
	Flat Land	102	17	119	32%
	Hilly Area	50	27	77	21%
	Total	308	64	372	100%
		83%	17%	100%	

Source: JICA T-COBSI Project Team (Feb 2014)

4) Influence of Flood

Inappropriateness of the topographic condition for the construction of permanent structure reaches a peak in such a place where there is an influence of flood. It was therefore asked whether farmland, houses, road are sometimes submerged during the flood time. It was revealed that 12% of the sites correspond to such an area, of course, not suitable to the upgrading at all (Table 1.3.20).

Table 1.3.20 Number of Sites by Influence of Flood

Influence of Flood	No. of Sites	%
Yes	47	12%
No	349	88%
Total	396	100%

Source: JICA T-COBSI Project Team (Feb 2014)

5) Bedrock

Considering the affordability of construction works, condition of bedrock matters a lot. If the bedrock is rocky, it is advantageous to minimize seepage through bedrock; however, it is far laborious to excavate the rocky foundation at intake. On stony or sandy ones, on the other hand, it becomes difficult to manage the water discharge during the dry work. It is noted that stability of the bedrock should not be much concerned with regard to the scale of the weir to be employed in this project.

Table 1.3.21, then, summarizes the number of sites by material and the depth of bedrock: "rocky," "stony," "sandy" and "silty" for the material and "deeper than 1m" and "shallower than 1 m" in thickness of the bedrock. As shown in the table, majority, 42% of the sites have bedrock with silty material, which are not really suitable for the permanent structure, which is followed by sandy (31%), stony (14%) and rocky (13%).

In terms of the thickness of the bedrock, furthermore, sites are nearly equally distributed into two groups more than/ less than 1m. It should be considered that surveyors may have had a difficulty to assess the thickness of the bedrock under water as they do not have much experience in engineering.

Table 1.3.21 Number of Sites by the Character and Depth of Bedrock

Item		Bed Rock			
		Deeper than 1m	Shallower than 1m	Total	
Material	Rocky	18	32	50	13%
	Stony	19	37	56	14%
	Sandy	53	66	119	31%
	Silty	90	75	165	42%
	Total	180	210	390	100%
		46%	54%	100%	

Source: JICA T-COBSI Project Team (Feb 2014)

1.4 INSTITUTION

1.4.1 Committee

1) Establish of Irrigation Scheme Committee

In and after the COBSI Study pilot project, irrigation scheme committees have been established by farmers for the maintenance of irrigation facilities (weir, furrow and irrigated land). The follow-up survey revealed that 112 sites established irrigation scheme committees before the COBSI Study. This means that committees existed even before the pilot project started in 2009. Since the start of the pilot project, 236 committees have been established, including the ones which were established after the pilot project. Thus, 47 committees in 2011, 21 committees in 2012 and 39 committees in 2013 shares 30% (107 committees) of total 361 sites.

Table 1.4.1 Number of Sites by Year Committee was Established

Year established	No. of response
<2009	112
2009	52
2010	77
2011	47
2012	21
2013	39
2014	0
N/A	13
Total	361

Source: JICA T-COBSI Project Team (Feb 2014)

2) Number of Committee Members

Currently, the total number of committee members is 3,668 in a total of 361 sites, with a share of 2,233 male and 1,435 female members. On average, each committee has 10.2committee members, 6.2 male and 4.0 female members. The largest committee is composed of 67 members, comprising of 39 males and 28 females.

Table 1.4.2 Number of Committee Members

Item	Male	Female	Total
TOTAL	2,233	1,435	3,668
AVERAGE	6.2	4.0	10.2
Largest Committee	39	28	67
Smallest Committee	1	1	2

Source: JICA T-COBSI Project Team (Feb 2014)

3) The Way to Select the Committee Members

Most of the committee members are elected by the members who participated in the construction work or rather scheme members. Of a total of 349 sites which is the valid response of this question, 269 sites (77%) selected the committee member by election, while "voluntary" is the next common way choosing committee members (14% sites). According to the counterpart officers, only those who maintain high social status can raise hand to take up these voluntary positions. For other instance, where the scheme is owned by a family (2% of the sites), no committee is required.

Table 1.4.3 Number of Committee Members

The way to Choose	No. of respondents	% of respondents
Elected by members	269	77%
Voluntary	48	14%
Elected by representative of villages in the scheme	32	9%
Sub Total	349	100%
Others	8	
BLANK	50	
NIL	6	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

4) Committee Member's with Another Roles in the Village/Community

There are some cases in which chairperson of the irrigation committee is selected from the village committee or alike. Regarding the role of chairperson in their communities, it was found that chairpersons have other roles in their village or community in 212 sites (55% of the valid responses), while they do not have any other role in their community in 170 sites.

Table 1.4.4 Chairperson's Another Roles in the Village/Community

Item	No. of Sites	%
Yes	212	55%
No	170	45%
Sub Total	382	100%
Blank	31	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Irrigation group committee chairperson takes up among other roles/positions in the village or community: village headman and village committee member (26 each), which is followed by village secretary (13), village committee chairperson (7), and cooperative chairman (7) as shown in Table 1.4.5. It seems that chairperson of the irrigation committee is often chosen from those who take an important role in the village.

Cooperative is a group which receives direction from MAL. The CCPU stands for Community Crime Prevention Unit, directed by the police. NHC stands for Neighborhood health community directed by Ministry of Health. These are also important groups that receive directions from government and transfer it to individual farmers.

Table 1.4.5 Chairperson's Another Role in the Village/Community

Rank	Other role	No. of Sites
1	Village headman	26
1	Village committee member	26
3	Village committee secretary	13
4	Village committee chairperson	7
4	Cooperative chairman	7
6	CCPU member	6
6	NHC member (neighborhood health	6
8	Village Committee Trustee	5
8	Lead farmer (MAL)	5
10	Church leader	4

Source: JICA T-COBSI Project Team (Feb 2014)

5) Registration of Irrigation Group

The registration of irrigation groups was not strongly promoted in the COBSI pilot project; however for better maintenance of irrigation facilities[1], registration is recommendable. Currently, 65 sites are registered (17% of the valid responses) and 317 sites (83%) are not yet registered. The oldest group was registered in 1987 and the latest one in 2013.

Table 1.4.6 Registration of Institution

Registration	No. of respondents	%
Yes	65	17%
No	317	83%
Sub Total	382	100%
Blank	28	
Nil	3	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

[1] Irrigation facilities cover weir, furrow and irrigated land.

6) Registration of Water Rights

To protect their right in water use, it was recommended that all irrigation schemes register their water rights with the Ministry of Mines, Energy and Water Development after construction of the schemes. However, only 18 sites as at present have water rights registered and 363 sites (95%) have not. Some sites have started the process of registration; however, the members have not confirmed with the district office if the procedure is completed or not. Some sites do not know the importance of water right registration. As of the registered committees, the oldest one registered their water right in 1960 and the latest one in 2011.

Table 1.4.7 Registration of Water Rights

Registration	No. of respondents	%
Yes	18	5%
No	363	95%
Sub Total	381	100%
blank	31	
Nil	1	
N/A	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

7) Collection of Water User's Fee

Of the 382 valid responses, only 24 sites collect water user`s fee from members. Among these 24 sites, 18 sites disclosed the amount they are collecting, as shown in Table 1.4.98. Out of 18 sites, 17 sites collect the fee annually and the amounts ranges from K5.0 to K200.0 per member.

Table 1.4.8 Collection of Water User`s Fee

Collection of Fee	No. of Sites
Yes	24
No	358
Total	382
Blank	31
Nil, N/A	0
Total	413

Source: JICA T-COBSI Project Team (Feb 2014)

The fee collected has several uses within the scheme; most of the sites use the money for maintenance of furrow, weir and their irrigated farm plot. They also use the money for buying food/refreshments at meetings or gatherings for maintenance works on the scheme. Other uses include using the money for funeral and renewal of certification such as water rights.

Table 1.4.9 Amount of Water User's Fee and Its Use

K	Unit	No. of Sites Responded	Use of Water Users' Fee
5	Year	2	For pumping water from the river,
10	Year	2	To buy fertilizer, seeds, and food for meeting
20	Year	4	To buy farming inputs (seeds, chemical fertilizer and pesticides), For maintenance of furrow. For renewal of certificate, To contribution towards funeral, For gatherings and meetings.
25	Year	2	For maintenance of furrow, To de-silt and buy food when working in the furrow.
30	Year	1	To use during cleaning of the weir
40	Year	1	For the maintenance of furrow
50	Year	2	For clearing the group garden, To maintain the water furrow and renewing water rights
5	Month	1	For maintenance of scheme
60	Year	1	For maintenance of scheme
100	Year	1	For weeding of the furrow.
200	Year	1	For maintenance of the weir.
TOTAL		18	

Source: JICA T-COBSI Project Team (Feb 2014)

8) Written Rules/ Regulation for the Maintenance of Irrigation Schemes

Table 1.4.10 indicates that 172 sites out of 389 (44%) have written rules/regulations for the management of schemes.

Table 1.4.10 Existence of Written Rules in the Scheme

Written Rule/ Regulations	No. of Sites	%
Yes	172	44%
No	217	56%
Sub Total	389	100%
blank	24	
Nil	0	
N/A	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

According to the responses from the 172 sites which have written rules, the rules were prepared by all the irrigation group members in 121 sites, by irrigation committee members in 24 sites, and by their community and village committee in 6 sites.

Table 1.4.11 Person Who Prepared the Written Rules

Prepared by	No. of sites
All Irrigation group members	121
Irrigation committee members	24
The community (Incl.village committee)	6
The cooperative	3
Specific person`s name	3
Secretary	2
The committee with agriculture officer.	2
Community and committee	1
Headman	1
Chief	1
The fish farmers group.	1
MAL	1
Other	6
TOTAL	172

Source: JICA T-COBSI Project Team (Feb 2014)

9) Periodical Committee Meeting

Of the 289 sites (74% of the valid responses), they conduct regular committee member meetings. On the other hand, 101 sites (26%) do not hold periodical meeting (Table 1.4.12). Table 1.4.13 also shows the frequency at which the meetings are held. Majority of respondents, 152 sites hold committee meeting once a month.

Table 1.4.12 Conduct of Periodical Committee Meeting

Periodical Committee Meeting	No. of Sites	%
Yes	289	74%
No	101	26%
Total	390	100%
Blank	23	
Nil	0	
N/A	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.4.13 Frequency of Periodical Committee Meeting

Rank	times	Unit	No. of Sites
1	1	Month	152
2	2	Month	36
3	1	3months	28
4	1	6months	18
5	4	Month	16
6	1	Year	11

Rank	times	Unit	No. of Sites
7	1	2months	8
8	3	Year	6
9	3	Month	3
10	1	1.5month	2
11	12	Month	1
12	16	Month	1
13	7	Year	1
Total			283

Source: JICA T-COBSI Project Team (Feb 2014)

10) Periodical Members' Meeting

Irrigation group member meeting, in which all the members of irrigation scheme are in attendance, 280 sites have regular meeting. The regularity and frequency of member meetings is shown Table 1.4.15. The meeting may include activities such as cleaning of furrow and weir. Out of the 273 valid responses, the majority of the sites thus 124 conduct the member meetings monthly.

Table 1.4.14 Periodical Member's Meeting

Periodical Member Meeting	No. of Sites	%
Yes	280	74%
No	100	26%
Sub Total	380	100%
Blank	33	
N/A. Nil	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.4.15 Frequency of Member's Meeting

Rank	Times	Unit	No. of Sites
1	1	month	124
2	1	3months	36
3	1	6months	27
4	1	year	25
5	1	2weeks	19
6	1	4months	16
7	1	week	15
8	1	2months	8
9	3	month	1
10	7	year	1
11	8	year	1
Total			273

Source: JICA T-COBSI Project Team (Feb 2014)

11) Issues Discussed in the Meeting

An open-ended question was applied to address the issues discussed at these meetings. According to the responses from 216 sites, among the issues addressed at the periodical meetings include: maintenance of furrow, water allocation, marketing of their products, collection of water users' fee for the maintenance of weir, conflict solution for allocating water, and use of furrow. The details of these responses will be described in the Progress Report No.2.

12) Conflicts over Allocation of Water within the Scheme

Water related issue is crucial all over the sites such as water distribution, water loss and water shortage. Table 1.4.16 shows that 66 sites face some kind of conflict when it comes to allocating water within the scheme (17% of the valid responses). Furthermore, the membership issue (e.g. who the original members are), and involvement of village headman and village committees to the irrigation scheme committee are listed.

Table 1.4.16 Conflicts within the Scheme

Any conflicts	No. of Sites	%
YES	66	17%
No	323	83%
Sub Total	389	100%
Blank	24	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

13) Complaints from the Farmers Downstream

Major complaint from farmers downstream is water shortage; defiantly this is caused by the excessive use of the water diverted to farmers' fields upstream by way of blocking the water. Of the 391 valid response 15% of the sites have complaints of water shortage from farmers downstream. Table 1.4.17 summarizes the responses.

Table 1.4.17 Complaints from Downstream

Complaints from Downstream	No. of Sites	%
Yes	60	15%
No	331	85%
Total	391	100%
Blank	22	
N/A, Nil	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

14) Complaint against the Farmers Upstream

Table 1.4.18 indicates that 66 sites out of 389 valid responses (17%) have complaints against upstream. The major complaint is about water distribution. Some sites claimed that the upstream site blocks water flow whenever they like. As discussed, there are some conflicts within and even beyond the scheme, suggesting a necessity of institutional arrangement within and among the schemes if any.

Table 1.4.18 Complaints from Upstream

Complaints against Upstream	No. of Sites	%
Yes	66	17%
No	323	83%
Sub Total	389	100%
Blank	24	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

1.4.2 Composition of the Irrigation Schemes

1) Number of Villages Where the Members come from

The numbers of villages comprised in the scheme is indicated in Table 1.4.19. Out of 366 valid responses, 163 sites are composed of only one village each, followed by 91 sites composed of 2 villages each, and 64 sites are formed by 3 villages each site.

Table 1.4.19 Number of Villages in the Scheme

Rank	No. of villages in the Scheme	No. of Sites
1	1 village	163
2	2 village	91
3	3 village	64
4	4 village	20
5	5 village	18
6	6 village	2
7	7 village	6
8	8 village	1
9	10 village	1

Source: JICA T-COBSI Project Team (Feb 2014)

2) Number of Interest Groups Existing in the Scheme

Farmer interest groups include: farming groups, cooperative groups, women groups, and fisher's groups. Table 1.4.20 shows the number of site by the number of interest groups exist in the scheme. The majority of the schemes only have one interest group (89 sites).

Table 1.4.20 No. of Groups in the Scheme

No. of Groups in the Scheme	No. of Sites
0 group	10
1 group	89
2 groups	38
3 groups	41
4 groups	13
5 groups	4
6 groups	2
7 groups	3
10 groups	1
23 groups	1
Blank	89
Nil	59
N/A	63
Total	413

Source: JICA T-COBSI Project Team (Feb 2014)

1.4.3 New Members

1) Acceptance of New Members from Inside/ Outside of the Scheme

304 sites out of a total of 389 valid responses (78%) accept new members and 85 (22%) do not accept. According to the response from an open-ended question, the conditions for accepting new farmers who are located within the same scheme include: payment of membership fee, participation and cooperation with other members in the maintenance work, and complying rules. Major answers are related to seeking cooperation with other members. In other word, members could be worried that new members do not take responsibility as like original members.

In most cases, the condition to accept new members from outside the scheme are similar to the conditions to the new members from the same scheme, such as payment of membership fee, cooperation with other members, participation on maintenance works, and following rules. The different case is where an outside member applies for land from the chief to join the scheme and/or applies membership to committee members.

Table 1.4.21 Acceptance of New Member

Accept New Member	No. of Sites	%
Yes	304	78%
No	85	22%
Sub Total	389	100%
blank	24	
Nil	0	
N/A	0	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Moreover, it's not always that new members are accepted, Table 1.4.22 shows the reasons not to accept new members. The recurrent one is inadequate irrigated land and second frequent is to avoid problems which can be caused by new members, which is followed by inadequate water. Some also answered that they maintain the scheme as a family; therefore they do not accept new members.

It seems that reasons not to accept members from outside are often related to land issues. Even if there is extra land, landownership may become a bottleneck for the candidates from outside. Regarding the

condition to accept new members from outside, major answers are related to seeking cooperation with current members and taking responsibilities to the allocated land. Same applies to the new members within the scheme, current members are probably worried that new members use current member's land without deep care as members and problems occur.

Table 1.4.22 Reasons not to Accept New Members

No.	Reason not to Accept New Members	No. of Sites
1	Inadequate irrigated land	12
2	To avoid problems occurred by new member	7
3	Inadequate water	5
4	Land ownership problem	4
5	No request from outsiders	4
6	Other existing available furrows	3
7	Furrow is not functional.	2
8	Free water (no need to be member)	2
9	To protect original member`s right	1
10	Distance	1
11	Scheme is just started	1
12	Want to keep current group size	1
13	No membership fee is paid	1
14	Committee is not functional	1
15	Individual belonging	1
16	Weir is not functional.	1
17	Not allow outsider to stay for good.	1
18	Not prepared yet.	1
	Total	51

Source: JICA T-COBSI Project Team (Feb 2014)

1) Existence of Beneficiaries from Outside the Scheme

In reality, 192 sites out of 357 sites (54%) do not have beneficiaries from outside, while, 165 sites (54%) have beneficiaries from outside. Table 1.4.24 summarizes the top 10 reasons why there are no beneficiaries from outside. The most frequent reason is "no request from outsiders to join the scheme (19 sites)," followed by "distance from outsider's residence," implying that the scheme is isolated from neighboring villages.

The third reason is about inadequate irrigated land for new members. This is also related to the fourth frequent reason, "land ownership problem." Most of the temporary schemes are composed of one village, and it seems that they are not willing to expand the irrigation area.

This can be connected to the landownership problem. For the villagers, land is vital. Some respondents say that they do not want outsiders to stay within their village longer because they are afraid of such a situation where their land is possessed by new comers. In this background, farmers are not even willing to extend the furrow to accept the new farmers from outside. Hence, the irrigated area may no longer expand even if water potential allows for exploitation.

Table 1.4.23 Existence of Outsiders in the Scheme

Item	No. of sites	%
Yes	165	46%
No	192	54%
Sub Total	357	100%
Other	56	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.4.24 Reasons for Not Accepting Outsiders

Rank	Reasons	No. of Respondents
1	No request from outsiders	19
2	Distance from outsider`s residences	15
3	Inadequate irrigated land (in the scheme)	11
4	Land ownership problem (incld. family owned scheme)	10
5	Other existing available furrows (in neighborhood)	8

Rank	Reasons	No. of Respondents
6	Inadequate water (in the scheme)	5
7	The scheme is not yet ready to accept outsiders.	5
8	No interest in irrigated cultivation	4
9	Furrow is not functional	3
10	Do not want to pay membership fee	2

Source: JICA T-COBSI Project Team (Feb 2014)

2) Allocation Method of New Irrigated Land

For the new members from "inside" of the scheme, 284 sites responded to how irrigation land is allocated. If the farmers have their own lands in the command area, they can use their own land. On the other hand, if farmers do not own land in the command area, major procedure to obtain the land around the furrow is firstly to ask for permission from authorities such as chief, village head, village committee, and irrigation scheme committees.

Some sites just allow new member to contact landowner to borrow land. Most of the sites ask new comers to pay for the land but a few minor cases do not request payment. Apart from payment and obtaining permission from authorities, the sites request new members to work well with original members and cooperate.

As regards new member from "outside" of the scheme, common procedure is almost the same as the one for the farmers from within the scheme. They need to get permission from authorities such as chief, village headman, village committee and irrigation scheme committee. And most of sites request for fee (payment) to allocate land.

As a whole, there are no significant differences in land allocation for the new farmers within and outside the scheme. In both cases, permission from authorities and payment for borrowing land are required for new members. Moreover, the permission is given not only by irrigation scheme committee but also by village chief, village head and village committee. Thus, accepting new member is under the village authority's decision. It seems that farmers pay serious attention to land allocation for new comers whether they come from inside of the scheme or outside.

1.4.4 Specific Roles for Men and Women

In this part, the gender balance in each specific work role is described. The questions were prepared to choose from the four choices: "mainly by men," "mainly by women," "equally," and "N/A" (N/A was given only some questions). It is a natural tendency for the respondents to answer "equally" to this kind of question. Therefore, in this section, focus is put on the differences between the number of responses given to "mainly by men" and "mainly by women," intending to unfold the real social structure behind.

Table 1.4.25 Gender Balance in Operation and Maintenance

Item	O&M of the irrigation system					
	Construction of weir	Gathering materials for weir	Repair of weir	De-silting of impound	Maintenance of furrow	Introducing water to the field
Mainly by men	43%	21%	41%	27%	28%	13%
Mainly by women	1%	10%	2%	2%	3%	2%
Equally	55%	69%	57%	55%	63%	85%
N/A	-[2]	-	-	16%	6%	-
Total	100%	100%	100%	100%	100%	100%

Source: JICA T-COBSI Project Team (Feb 2014)

As far as the construction and repairing of weir are concerned, male members tend to participate in the activity more than women. Conversely, daily activities such as de-silting of impound, maintenance of

[2] This question did not have "N/A" in the choices.

furrow, and on-farm water management tend to be done equally between men and women. It seems that these differences are as a result of culture, in which men tend to be in charge of social activities as a representative of household and women only usually take up a role in domestic work such as daily activities.

Apparently, for cultivation and harvesting, the work is equally shared between male and female members, especially in cultivation activities. There are some activities in which female members participate slightly higher than male members, i.e. weeding, irrigated vegetable and irrigated beans, seem to require gentle skill to handle the crops—that is the possible reason why these activities are done more by women.

Table 1.4.26 Gender Balance in Cultivation and Harvesting

Item	Cultivation				Harvesting			
	Preparation of the field	Seeding	Applying fertilizer	Weeding	Vegetable (irrigated)	Beans (irrigated)	Rain-fed Maize	Rice
Mainly by men	20%	10%	6%	3%	6%	3%	6%	3%
Mainly by women	1%	10%	6%	11%	10%	18%	2%	3%
Equally	79%	81%	87%	84%	83%	64%	81%	42%
N/A	-	-	2%	2%	-	15%	10%	52%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Source: JICA T-COBSI Project Team (Feb 2014)

Marketing has more than one activity in it. Basically, both women and men are involved in all activities. However there is a tendency that activities which need physical power such as carrying products to market, and selling rain-fed maize (usually farmers bring maize to the collection points) are done by male members. It is remarkable that, with 36% of the valid responses, women keep money realized from the sale of the product. However, 18% of the responses indicated that the decision making in spending the money is done by the male members.

Table 1.4.27 Gender Balance in Marketing

Item	Marketing					
	Carrying products to the market	Selling products in the market	Selling to middleman at the farm gate	Selling rain fed maize	Keeping money	Decision making in spending money
Mainly by men	25%	12%	10%	16%	10%	18%
Mainly by women	11%	24%	14%	10%	36%	4%
Equally	62%	58%	63%	65%	51%	76%
N/A	2%	5%	13%	9%	3%	3%
Total	100%	100%	100%	100%	100%	100%

Source: JICA T-COBSI Project Team (Feb 2014)

1.5 OPERATION AND MAINTENANCE

1.5.1 Operation Works

1) Water Allocation in the Scheme

Table 1.5.41 shows the number of sites and type of major water allocation method in each scheme. Among the listed water allocation methods, 46% of the 386 valid responses apply the "rotation" approach. The "no rule," approach rates at 38% in which farmers can do irrigation anytime they want. The "discuss with neighbors case by case" approach is at 14%. As far as the team members have interviewed, there were not much cases in which farmers do rotational irrigation under a clear-cut role or a written rule. Therefore, it can be anticipated that the rotation is "naturally" practiced without rule or by discussing with neighbors, unless they face a severer water shortage.

Table 1.5.1 Allocation Method among the Farm Plots in the Scheme

Method	No. of Sites	Share
Rotation	179	46%
No rule (anytime)	147	38%
Discuss with neighbors case by case	53	14%
Others	7	2%
Total	386	100%

Source: JICA T-COBSI Project Team (Feb 2014): Based on a close-ended question with four choices above

2) Water Control Method to Farm Plot

To control water into farm plots from the furrow, majority of the sites, 93% of a total of 384 valid responses, carry out an orthodox method, that is, to open and close a cutout at the furrow. As it is a smallholder irrigation scheme where an earth canal is employed, it seems easy for farmers to open and close the cutout by themselves. It should be noted, however, that there are 16 sites where conduit pipes are used—there can be a place to observe as advanced practice.

Table 1.5.2 Water Control Method to Divert into Each Farm Plot

Method	No. of Sites	Share
Open and close a cutout at the furrow	358	93%
Using pipe	16	4%
Others	10	3%
Total	384	100%

Source: JICA T-COBSI Project Team (Feb 2014): Based on a close-ended question with three choices above

3) Use of Manual

A survey was undertaken on whether farmer groups have any type of manual on operation and maintenance of irrigation facilities. As shown in Table 1.5.3, however, there are only 24 cases (6%) that have a written operation and maintenance manual in their scheme. Probably, they acknowledged the manual given during the pilot project of the COBSI Study.

Table 1.5.3 Water Control Method to Divert into Each Farm Plot

Existence of Manual	No. of Sites	Share
No	361	94%
Yes	24	6%
Total	385	100%

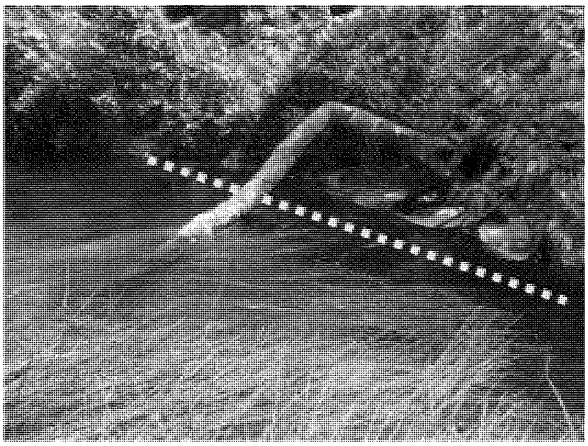
Source: JICA T-COBSI Project Team (Feb 2014)

1.5.2 Maintenance Works

1) Management of Weir during Rainy Season

The frequency in the arrangement of weir during rainy season and the consequent of the weir condition is shown in Table 1.5.4. Against the instruction given in the COBSI Study, only 7% of the sites dismantle the weir. In reality, 50% of the sites leave the weir as it is and another 43% open only a part of weir to release water. It implies that farmers may not consider it necessary as there is a high chance that the weir remains as it is even during rainy season.

In fact, the weir is completely flushed away on only 15% of the sites where weir is kept as it is. Weir is generally fine at 56% (17% and 39%) of the sites. Looking at all the responses, furthermore, weir remains as it is at 15% of the sites, and only some parts are broken at 34% of the sites. Bottom line is that weir is completely flushed away at 19% of the sites. Simple irrigation weir is quite stable than what



An incline-type weir holding increased amount of water during rainy season—simple irrigation weir is strong

was expected at the beginning. Of course, it depends on the type of weir, topography of the site and the amount of water though.

Note that there is some inconsistency in the relationship between the arrangement of the weir and the consequence of the weir. For example, even after "dismantling the weir almost completely," there are some sites where the weir still "remains as it is (2 responses)" or "only some parts are broken (2 responses)." In this regard, there are more number of responses, showing "completely flushed away (20 responses) to the site where weir is "dismantled almost completely." Possibility is that, farmers decided to dismantle the weir as it was flushed away in the previous season, or, they completely dismantled just after the weir is damaged. The data will be further clarified in the next phase.

Table 1.5.4 Management of Weir during Rainy Season

Arrangement \ Condition	Remain as it is	Only Some Parts are Broken	Broken but the Main Structure Remains	Completely Flushed Away	Total	
Leave the weir as it is	29	67	52	26	174	50%
	17%	39%	30%	15%	100%	
Open a part of weir to release water	22	51	55	21	149	43%
	15%	34%	37%	14%	100%	
Dismantle the weir almost completely	2	2	1	20	25	7%
	8%	8%	4%	80%	100%	
Total	53	120	108	67	348	100%
	15%	34%	31%	19%	100%	

Source: JICA T-COBSI Project Team (Feb 2014)

2) Implementation Status of Maintenance Works

On the seven types of maintenance works, Table 1.5.5 summarizes the implementation status: 1) checking the water flow at the weir, 2) patrolling along the furrow, 3) de-silting at upstream of weir, 4) de-silting of furrow, 5) cleaning/weeding of furrow, 6) repairing of weir, and 7) repairing of furrow. The total number of each row shows the number of valid responses to the respective item.

Among the seven items, implemented the most are cleaning and weeding of furrow (88%) and patrolling of furrow (87%), which are followed by checking water flow at the weir (84%), repairing furrow (83%) and de-silting of furrow (77%). These works are done roughly on 80% of the sites. On the other hand, de-silting of weir is conducted at a lesser number of sites (58%). Acceptably, de-silting of impoundment is a hard work and therefore farmers may hesitate to do it until the facility becomes malfunctioned.

Table 1.5.5 Implementation Status of Maintenance Works

Type of Management	Yes	No	Total
Check Water Flow	316	60	376
	84%	16%	100%
Patrol Furrow	325	48	373
	87%	13%	100%
De-silting Weir	216	155	371
	58%	42%	100%
De-silting Furrow	268	82	350
	77%	23%	100%
Cleaning and Weeding Furrow	312	44	356
	88%	12%	100%
Repairing Weir	272	79	351
	77%	23%	100%
Repairing Furrow	293	58	351
	83%	17%	100%

Source: JICA T-COBSI Project Team (Feb 2014)

Note that a certain percentages of sites conduct no maintenance work. The beneficiaries at these sites may regard the irrigation facility as maintenance-free. It is thus not suggestive to select such sites for the upgrading of the structure during the project. In any case, it is necessary to encourage the farmers to conduct operation and maintenance works as a group and it will also serve to enriching the level of

institutional capacity of the group.

3) Frequency of Maintenance Works

The frequency of maintenance works for the seven types of works listed above are summarized in Table 1.5.6. Total number of each column shows the number of valid responses to each attribute.

As shown in the table, majority (31%) of the sites check water flow at the weir "2-4 times per month," 27% at a rate of "8-12 per year." Thus, it is often done on average once a month up to every week. Patrolling of furrow showed a similar tendency: 38% for 2-4 times per month and 21% for 8-12 times per year. It is clear that the frequency of checking/ patrolling may be influenced by the distance from the residence area to the irrigation scheme. If it is closer, farmers can easily check the weir or furrow—frequency would naturally increase. In the course of the project, it will be instructed to conduct checking water flow and patrolling furrow every day in principle during the entire season.

Table 1.5.6 Frequency of Maintenance Works

Frequency of O&M	1. Check Water Flow		2.Patrol Furrow		3. De-silt Weir		4. De-silt Furrow	
	Freq.	Share	Freq.	Share	Freq.	Share	Freq.	Share
Once a year or less	23	7%	11	3%	37	18%	54	20%
2-7 times per year	38	12%	21	6%	54	26%	68	26%
8-12 times per year	86	27%	67	21%	65	32%	83	31%
2-4 times per month	97	31%	123	38%	45	22%	48	18%
2-4 times per week	31	10%	56	17%	1	0%	7	3%
More frequently	38	12%	47	14%	3	1%	4	2%
Do Not Do	60	16%	48	13%	155	43%	82	24%
Total	372	100%	372	100%	359	100%	345	100%
Average	1.5	times/ week	1.9	times/ week	1.6	times/ month	1.6	times/ month

Frequency of O&M	5. Clean Furrow		6. Repair Weir		7. Repair Furrow	
	Freq.	Share	Freq.	Share	Freq.	Share
Once a year or less	93	30%	116	45%	82	29%
2-7 times per year	93	30%	69	27%	58	21%
8-12 times per year	78	25%	43	17%	79	28%
2-4 times per month	37	12%	30	12%	52	19%
2-4 times per week	5	2%	5	2%	9	3%
More frequently	0	0%	0	0%	0	0%
Do Not Do	44	13%	79	23%	58	17%
Total	350	100%	342	100%	338	100%
Average	0.8	times/ month	0.7	times/ month	1.2	times/ month

Source: JICA T-COBSI Project Team (Feb 2014)/ Note: average does not include zero.

The frequency of de-silting of impoundment is slightly lower than checking and patrolling. 32% of the sites do it 8-12 times a year, which is followed by 2-7 times per year (26%). Frequency in de-silting of furrow is nearly the same: majority of the sites (31%) do it 8-12 times per year—nearly every month. It implies that de-silting of weir and furrow are conducted at the same time. Considering relatively high frequency of de-silting activities, it is also assumed that de-silting works may be done part by part.

Furthermore, frequency in cleaning of furrow rated lower than de-silting works: 30% is for 2-7 times per year and another 30% is for once a year or less. It also suggests that, on contrary to the de-silting work, cleaning of furrow is usually managed thoroughly along the entire scheme as a seasonal work of the farmers' group.

Repairing works of weir and furrow rated at 45% 28% once a year and less respectively, which is followed by 8-12 times per year (28%). This concludes that in general repair works are carried out at the beginning of the dry season unless there happens to be damage/breakage during the dry season

1.6 FARMING

1.6.1 On-Farm Irrigation Method

1) Type of On-Farm Irrigation Method Practiced

In the pilot project of the COBSI Study, several on-farm irrigation methods were introduced through the provision of training and technical manuals. As shown in Table 1.6.1, majority (51%) of the on-farm irrigation methods remain as bucket irrigation, in which farmers scoop water from furrow to irrigate crops—tiresome for them. Good aspect is that furrow irrigation has become the major on-farm irrigation method in 40% of the sites. This result suggest the necessity of further promotion of easier method such as furrow, sunken and border strip irrigation instead of bucket irrigation.

Table 1.6.1 Type of On-Farm Irrigation Method

Irrigation Method	No. of Site	%
Bucket	199	51%
Furrow	156	40%
Sunken	30	8%
Border strip	3	1%
Others	1	0%
Total	389	100%

Source: JICA T-COBSI Project Team (Feb 2014)

2) Reason to Choose the On-Farm Irrigation Method

In relation to the type of on-farm irrigation method, it was asked what the main reason to have chosen the above method. Table 1.6.2, farmers have chosen the above mentioned method based on the recommendation by extension officers in 48% of the respondent sites. The next popular reason was that it was popular among the farmers (36%) and following the parents' way of doing (14%). As far as on-farm irrigation is concerned, farmers still follow others' way of doing unless instructed. However, cross-tabulation of these two factors did not show clear tendency.

Table 1.6.2 Type of On-Farm Irrigation Method

Reason	No. of Site	%
By CEO/BEO	171	48%
Popular	130	36%
Parents' way	51	14%
Others	8	2%
Total	360	100%

Source: JICA T-COBSI Project Team (Feb 2014)

1.6.2 Choice of Crops

1) Change in the Type of Crops (from Year Established to Present)

The most popular cultivated crops and their area in the scheme may have changed from the time the scheme was opened to date. Table 1.6.3 indicates the number of sites wherein the type of crop that was ranked the first in terms of the area cultivated have changed and not changed. In 227 sites out of 397 sites (57%), the type of the first ranked crops was kept as it was. On the other hand, 170 out of 397 (43%) have experienced a change in the type of crop which are first ranked in terms of the area cultivated. In such sites, farmers have orchestrated the types of crop in accordance with the market trend or whatsoever.

Table 1.6.3 Change in the Type of 1st Crop in the Scheme (Area Cultivated)

Type of the First Crop	No. of Sites	%
Not Changed	227	57%
Changed	170	43%
Total	397	100%

Source: JICA T-COBSI Project Team (Feb 2014)

To be more precise, Table 1.6.4 shows the type of crops that are ranked the first, second or third within each irrigation scheme in two time series when the scheme was established and at present (2013). In the table, "No. of site-points" means the accumulated number of the sites, in which a particular crop gets a place within 3rd rank. As shown in the table, tomato and rape have been steadily popular in many schemes. In typical irrigation scheme where these crops were cultivated, tomato shared 38% of the total area when the scheme was established and 39% today.

As at present, cabbaged has dropped from third to fifth and onion has gone up to the third. It can be assumed that tomato and rape are crops that are cultivated as a base crop and farmers adjust the area of other crops according to market trend or other conditions. The reasons for the change are discussed in the following section.

Table 1.6.4 Change in the Type of Crop in Area (1st Ranked)

Rank	Initial			Rank	Present		
	Crop	No. of Site-Points	Typical Share in the Scheme		Crop	No. of Site-Points	Typical Share in the Scheme
1	Tomato	295	38%	1	Tomato	270	39%
2	Rape	239	33%	2	Rape	201	35%
3	**Cabbage**	148	31%	3	**Onion**	144	27%
4	**Onion**	124	25%	4	Maize	111	34%
5	Maize	98	38%	5	**Cabbage**	106	29%
6	Chinese Cabbage	57	29%	6	Chinese Cabbage	46	31%

Source: JICA T-COBSI Project Team (Feb 2014)

2) Reasons for the Change in Type of Crops

There are several reasons that lead farmers to change the type of crops cultivated under irrigation from the time when the scheme was established/ improved to present. The various reasons to change the type of crops can be categorized into two major categories: "crop management" and "marketing," which is summarized in Table 1.6.5. Overall, issues in marketing shares 59% of the total number of sites that responded to this question, while crop management shares 26%.

Particularly, marketing issue includes "high demand (27%)," "more profit (20%)," and "access to established market (10%)." With no doubt, farmers try to orchestrate the types of crops in accordance with the market trend. To be sure, issues of crop management matter too. It is sometimes difficult to produce such crops that are popular in the market due to the "shortage of water (5%)," "disease and pest (5%)," and "difficulty (easiness) to manage (4%)"—that is also a reason why prices of these crops are high in the market.

Table 1.6.5 Reasons for the Change in Types of Crops

Main Issue	Sub Issue	No. of Sites	Percent
Crop Management	Easy to manage	14	4%
	Crop rotation	10	3%
	Shortage of water	18	5%
	Disease and pest	16	5%
	Other Crop Management Issues	30	9%
	Sub Total	88	*26%*
Marketing	Access to Established Market	33	10%
	High Demand	92	27%
	More Profit/ High Price/ Price Stability	68	20%
	Other Marketing Issues	6	2%
	Sub Total	199	*59%*
Others		52	*15%*
TOTAL		**339**	**100%**

Source: JICA T-COBSI Project Team (Feb 2014), Note: Summarized based on an open-ended question.

In the meantime, there are various other factors to consider when changing the types of crops. For example, diversification of crops, preservation of crops, lack of knowledge, shortage of manpower, and lack of quality seeds are pointed out as other issues in crop management. Also, other marketing

issues include longer duration of high prices, selling as business, less competitors, transportation problem. Furthermore, there are some other factors like: recommended by CEO, improving nutrition status, food security, for lesser cases of theft, and intervention by FRA.

3) Issues to Consider for the Selection of Crops

To ensure precise consideration for the selection of crops, questions were asked on what issues were needed to be considered for the selection of the crops under irrigated farming during dry season by the way of close-ended question with 11 choices. As shown in Table 1.6.6, the most frequent answer to the first choice was "consume at household," which was followed by "sold in high price." On the other hand, for the second choice, "sold in high price" had the highest frequency, while "easy to grow" reached top ranked for the third choice. As the overall frequency, "sold in high price" comes the top-ranked (getting 28% of the total responses), followed by "consume at household" and "easy to grow."

This indicates that farmers are generally directed toward the high price but they put the self-sufficiency as the first priority. Further, to mitigate the risk of failure, farmers attempt to choose such a crop which is easy to grow—quite a reasonable strategy.

Table 1.6.6 Issues to Consider for the Selection of Crops

Selection Criteria	1st Choice	2nd Choice	3rd Choice	Total	%
Sold in high price	**148**	**145**	33	326	28%
Consumed at household	**189**	**81**	29	299	26%
Easy to grow	23	49	**102**	174	15%
Requested by buyers	21	48	**75**	144	12%
Grown in short period	2	23	61	86	7%
Grown without fertilizer	2	11	21	34	3%
Recommended by BEO/CEO		9	19	28	2%
Improve soil fertility	2	13	10	25	2%
Differentiate from other farmers		4	20	24	2%
Imitate the other farmers		1	10	11	1%
Others	1	1	1	3	0%
Total	388	385	381	1,154	100%

Source: JICA T-COBSI Project Team (Feb 2014), Note: Based on a close-ended question with 11 choices listed above.

1.6.3 Use of Irrigated Area during Rainy Season

1) Use of Irrigated Area during Rainy Season

The COBSI approach is employed to promote irrigated agriculture in dry season. In this regard, the question is how the farmland is being utilized after the dry season agriculture: whether farmers continue/stop cultivation of vegetables? Table 1.6.7 shows the land use during the rainy season of the farmland where irrigated farming was practiced during dry season. In the case of 360 valid responses, 30% of the land is used for maize cultivation as to grow staple crop.

Of the total area, 25% is not cultivated for irrigation and is left as it was in the rainy season (left as it was). This is probably because this area is affected by excessive water or farmers cannot manage this much area as they like to expand the area for maize cultivation during rainy season. Vegetable cultivation is continue in 14% of the total area in the rainy season

On the other hand, beans is cultivated in about one fourth (24%) of the land, thus farmers can enjoy the harvest of this crop and the improved soil fertility enhanced by the nitrogen fixation function of legume. In terms of the soil improvement, 15% of the land is treated for the traditional compost-making called "fundikila," where crop residues are incorporated into the soil of seedbed to decompose for the next cropping season.

Table 1.6.7 Use of Farmland during Rainy Season

Selection Criteria	Average
Maize	30%
Left as it was (farrow)	25%
Beans	24%
Fundikila (compost making)	15%
Vegetables	14%
Total	100%
No. of Responses	360

Source: JICA T-COBSI Project Team (Feb 2014),
Note: Based on a close-ended question with 5 choices listed above.
Respondents were asked to indicate the percentage of each choice

2) Major Crops in Rainy Season

The survey showed that farmers cultivate vegetables and beans even during the rainy season on the same filed where vegetables were cultivated in dry season. Focus at this stage is to know what kinds of crops are actually cultivated in rainy season. Ranking of the crops in rainy season are shown in Table 1.6.8 in terms of the area cultivated. "Maize" is the most grown at a total of 270 sites of the 382 valid responses, while "beans" is cultivated with the highest number (119) for the second rank. For the third rank, in addition, groundnuts and beans received nearly the same points, 79 and 75 sites respectively. As such, farmers may prefer cultivating maize as staple crop compared to vegetables that could easily be affected by pests and diseases, or damaged by strong rainfall during rainy season.

Table 1.6.8 Popular Crops for Rainy Season Cultivation in Irrigated Area

Rank	First Rank		Second Rank		Third Rank	
	Crop	No. of Sites	Crop	No. of Sites	Crop	No. of Sites
1	Maize	270	Beans	119	Groundnuts	79
2	Beans	28	Groundnuts	57	Beans	75
3	Tomato	21	Cassava	38	Rape	31
4	Cassava	18	Maize	36	Cassava	25
5	Rape	15	Tomato	34	Cabbage	22
6	Cabbage	8	Rape	21	Tomato	20
7	Groundnuts	7	Cabbage	20	maize	16
8	Onion	6	Sweet Potato	6	Sweet Potato	15
9	Others	9	Others	36	Others	77
	Total	382	Total	367	Total	360

Source: JICA T-COBSI Project Team (Feb 2014),

1.6.4 Change of the Soil Condition

1) Change in Soil Fertility

The repeated cultivation of vegetables enabled by the introduction of irrigation may deplete the soil fertility. With this concern, the change in soil fertility from the year irrigated farming started to present (2013) was addressed. As shown in Table 1.6.9, soil fertility was evaluated "good" at 64% of the valid responses (sites) and there were only 4 sites that evaluated it "bad." After the continued cultivation of the vegetables, share of "good" decreased to be 51%, instead, "fair" increased to be 46%, showing some evidence of soil degradation. However, there still are only 3% of the sites that claim the soil quality bad.

It is also observed that on 68% of the sites the soil fertility remained the same, "good is good," and "bad is still bad." And, on 23% of the area, soil fertility has degraded. It should also be noted that soil fertility has improved in 9% of the sites, attributed probably to good soil management. Note that these results are based on a question made to the representative of each sites (scheme) and may indicate quite a general picture of the site.

Table 1.6.9 Change in Soil Fertility

Soil Fertility		Present				
		Good	Fair	Bad	Total	%
Initial	Good	161	83	2	246	64%
	Fair	34	93	5	132	35%
	Bad	0	0	4	4	1%
	Total	195	176	11	382	100%
	%	51%	46%	3%	100%	
Improved		34	0	-	34	9%
Degraded		-	83	5	88	23%
Stays the Same		161	93	4	258	68%

Source: JICA T-COBSI Project Team (Feb 2014)

2) Use of Compost

It is important to analyze and conclude what farming methods maintain the soil fertility. Table 1.6.10 summarizes the use of compost over the irrigation period to present. When the scheme was opened, 76% of the sites did not practice compost and as at present, in 63% of the sites, the use of compost is still "not popular." This indicates that the use of compost may not have contributed to the soil improvement in the target area if at all. In fact, popularity stays the same at 80% of the sites, implying that behavior change has not occurred much in the use of compost. Thus, adaptability of the technology is increasingly important in the domain of soil improvement.

Table 1.6.10 Change in the Use of Compost

Use of Compost		Present			
		Popular	Not Popular	Total	%
Initial	Popular	78	14	92	24%
	Not Popular	64	228	292	76%
	Total	142	242	384	100%
	%	37%	63%	100%	
Become Popular		64	-	64	17%
Become Unpopular		-	14	14	4%
Stays the Same		78	228	306	80%

Source: JICA T-COBSI Project Team (Feb 2014)

3) Use of Chemical Fertilizer

Similarly to the use of compost, change in the popularity of the use of chemical fertilizer was analyzed. As shown in Table 1.6.11, use of chemical fertilizer was pronouncedly high since the beginning of the schemes (90%) and it even reached 97% by today. Thus, it is no doubt that farmers in the target area apply chemical fertilizer. It is also assumed that better soil fertility claimed by the farmers is attributed to the application of chemical fertilizer.

Table 1.6.11 Change in the Use of Chemical Fertilizer

Use of Fertilizer		Present			
		Popular	Not Popular	Total	%
Initial	Popular	346	3	349	90%
	Not Popular	29	9	38	10%
	Total	375	12	387	100%
	%	97%	3%	100%	
Became Popular		29	-	29	7%
Became Unpopular		-	3	3	1%
Stays the Same		346	9	355	92%

Source: JICA T-COBSI Project Team (Feb 2014)

1.6.5 Other Use of Irrigation Water

1) Number of Fishponds

Diverted water enabled by the irrigation scheme is used not only for farming but also used as a source of various activities in rural livelihood such as washing clothes, drinking water, bathing and other

household needs. Among all, fish culture provides farmers with a good source of income and nutrition. Table 1.6.12 summarizes the number of fishponds constructed through COBSI activity in comparison with the situations of the year when the scheme was constructed and present.

Of the 223 valid responses (sites), from the time the scheme was constructed to date, more than 60% of the schemes do not have fishponds. Yet, there are a number of sites that have fishponds, 17% of the sites have 1-5 fishponds per site, 10% have 6-10 fishponds per site; and 8% with more than 11 fishponds per site. In fact, 25% of the sites have increased the number of fishponds by today.

Table 1.6.12 Change in the Number of Fishponds

No. of Fish pond		Present							
		0	1-5	6-10	11-20	21-30	>30	Total	%
Initial	0	121	11	5	2			139	62%
	1-5	11	22	13	3		2	51	23%
	6-10	8	3	5	4	3		23	10%
	11-20	3	2		3	1		9	4%
	> 30						1	1	0%
	Total	143	38	23	12	4	3	223	100%
	%	64%	17%	10%	5%	2%	1%	100%	
Increased			18	21	11	4	2	56	25%
Decreased		22	8	1	0	0	0	31	14%
No change		121	12	1	1	0	1	136	61%

Source: JICA T-COBSI Project Team (Feb 2014)

Note: Numbers of sites for increment and decrement are assessed based on individual data.

There might be some locational variations in the development of fishponds depending on slope, availability of water and historical background in fish culture or fish eating. The number of sites with and without fishponds with the actual number of fishponds by district, which is based only on the valid responses, is tabulated in Table 1.6.13. As shown in the table, Kawambwa and Mwense of Luapula province shows quite high percentages in the number of sites with fishponds as per a total number of sites in each district (76% and 62% respectively).

Furthermore, Kawambwa and Mungwi show remarkably high figures in the actual numbers of fishponds (325 ponds and 152 ponds respectively). Districts along Luapula River have been engaged in fishing and fish culture for a long time and they are also target districts of PLARD that promoted fish culture, all of which may have contributed to the high number of sites with fishponds in these area. It should be further noted that there are some needs of the trainings for fishpond making and fish culture as to be discussed 1.6.7 in this report.

As the government promotes fish culture as a nutrition improvement activity, further promotion associated with fish farming may be needed in this project, including the collaboration with Peace Corps Volunteers who are engaged in this sub-sector.

Table 1.6.13 Number of Sites with and without Fishponds by District

District	Without Pond	%	With Pond	%	Total	%	No. of Ponds	%
Kasama	14	78%	4	22%	18	100%	57	6%
Luwingu	16	62%	10	38%	26	100%	67	8%
Mbala	17	77%	5	23%	22	100%	11	1%
Mporokoso	7	54%	6	46%	13	100%	56	6%
Mungwi	20	54%	17	46%	37	100%	**152**	**17%**
Isoka	11	73%	4	27%	15	100%	4	0%
Mpika	22	73%	8	27%	30	100%	77	9%
Nakonde	14	78%	4	22%	18	100%	23	3%
Kawambwa	4	24%	13	**76%**	17	100%	**325**	**37%**
Mansa	7	70%	3	30%	10	100%	2	0%
Millenge	1	100%	0	0%	1	100%	34	4%
Mwense	5	38%	8	**62%**	13	100%	52	6%
Nchelenge	6	86%	1	14%	7	100%	22	2%
Total	144	63%	83	37%	227	100%	882	100%

Source: JICA T-COBSI Project Team (Feb 2014)

1.6.6 Problems in Farming under Irrigation

Some farmers have experience in irrigated farming especially under Dambo irrigation, while for others it might have been a first trial.. In any case, there are various types of challenges farmers have encountered. Based on an open-ended question, these problems can be categorized into four major issues as summarized in Table 1.6.14.

The major problem faced by farmers is "irrigation;" 40% of response face this problem, in which 35% point of the sites face a lack/inadequacy of irrigation water. Even with an improved irrigation system, river water level goes down especially at the end of dry season, by this growth of crops is badly affected. Specifically, increase in farmer population and leakages on the irrigation facilities are pointed out as the causes of water shortage. To cope with these kinds of problems, introduction of rotational irrigation system and countermeasure works against leakage using soil cement, for example, should be considered.

On the other hand, issues associated with "farming" share another 30% of the total responses, which includes "pest, disease and weed problems (19%)" and "lack of skills and knowledge (6%)," which are followed by soil problems (5%). In reality, there are some sites requesting technical assistance in the use of botanical pesticides and making of improved compost. Furthermore, there are some comments pointing to the excessive water in the furrow which led to soil erosion—implying the necessity to install affluent outlets along the canal.

Needless to say, an issue of labor has already become obvious in some sites, sharing 9% as a whole. In fact, some of them linked the labor issue with the tiresome caused by bucket irrigation—promotion of appropriate on-farm irrigation method is still needed.

The lack of farm implements and inputs, such as fertilizer, remain the problematic issue for farmers. Lack of proper implements, such as sprayer, was also claimed as a cause of inadequacy in pests and disease control. In addition, there are some other particular examples of problems in irrigated agriculture i.e.: farmers on the upper area of the scheme block the furrow to divert water into the individual fields. And someone deconstructed the weir for any reason—suggesting some intervention for better institutional arrangement such as establishment and functioning of irrigation committee.

Table 1.6.14 Problems in Farming under Irrigation

Main Issue	Sub Issue	Frequency	Percent
Irrigation	Lack of water	170	35%
	Poor irrigation facilities	15	3%
	Sedimentation	8	2%
	Sub Total	193	*40%*
Farming	Pest, disease, and weeds	93	19%
	Soil problem (fertility, leaching)	10	2%
	Soil erosion	15	3%
	Lack of skills and knowledge	27	6%
	Sub Total	145	*30%*
Labor	Labor (general)	26	5%
	Laborious for bucket irrigation	17	3%
	Sub Total	43	*9%*
Inputs	Lack of farm implements	17	3%
	Lack of inputs	51	10%
	Sub Total	68	*14%*
Market		11	2%
Others		28	*6%*
TOTAL		**488**	**100%**

Source: JICA T-COBSI Project Team (2013), Note: Summarized based on an open-ended question.

1.6.7 Needs to Learn New Technologies

Given a wide range of problems that the farmer faces in irrigated farming, it is appropriate for the farmers to learn new technologies. As shown in Table 1.6.15, technology needs are summarized into four main issues: irrigation, cropping, conservation, and integrated agriculture. With reference to the number of responses, issues related to "conservation" shares 33% of all, which includes the needs to learn "soil improvement techniques (19%)," "conservation farming (12%)," and "organic farming (3%)." It is in line with the fact that many farmers claimed "soil problem" as one of the major problems as discussed in chapter 1.6.6.

This high level of interest in soil improvement and soil conservation might have derived from the past projects including the pilot project of the COBSI Study in which BOKASHI compost was taught as well as the government's initiative in conservation farming sponsored by the FAO.

Needs for the training opportunities in cropping (27%) and irrigation (25%) are also expressed. As of cropping, general crop management shares 12%, which is followed by crop protection (6%), appropriate use of chemicals (4%), and crop rotation (4%). Indeed, they are somehow related to pest and disease control.

The survey confirmed the need for further training on "irrigation method (21%)" and construction/ management of irrigation facilities (5%), suggesting some difficulties in management of weirs/furrows. In addition, use of diverted water for fish farming and also integrated farming are requested. Many farmers are willing to diversify their way of farming by introducing many different commodities including fish and small livestock.

Table 1.6.15 Needs for the Training Opportunities for New Technologies

Main Issue	Specific Issue	Frequency	Percent
Irrigation	Construction/management of irrigation facilities	30	5%
	Irrigation method	129	21%
	Sub Total	159	*25%*
Cropping	Crop management (general)	73	12%
	Crop rotation	24	4%
	Crop protection (pest and disease)	40	6%
	Use of chemicals (incl. botanical)	25	4%
	Others (rice, fruits, seeds)	7	1%
	Sub Total	169	*27%*
Conservation	Conservation farming	72	12%
	Organic farming	16	3%
	Soil improvement (compost making)	121	19%
	Sub Total	209	*33%*
Integrated Agriculture	Fish pond/ fish culture	29	5%
	Others (integrated farming)	16	3%
	Sub Total	45	*7%*
Others		43	*7%*
TOTAL		**625**	**100%**

Source: T-COBSI Project Team (2013), Note: Summarized based on an open-ended question.

1.7 MARKETING

1.7.1 Marketing Arrangement

The survey would be incomplete without addressing the marketing of the farmer produce. The arrangement may vary among individual farmers: one may sell bulk of produces at the big market in provincial capital or other province, while the other may sell small amount of produces in the village. In this section of the report, thus typical market arrangement of each scheme is discussed based on the response from the representatives of the schemes.

1) Type of Market and Modality of Selling

Firstly, Table 1.7.1 summarizes the number of sites, type of market and the modality of selling. Type of market is categorized into 5 types: 1) market in the district capital, 2) market near but outside the village, 3) kiosk/stand in the village, 4) selling along a trunk road, and 5) market at provincial capital. As shown in the table, major market place is at district capital for 50% of the sites, which is followed by market near but outside the village (28%). Of course, there should be some variations even within schemes; but this result suggests that farmers prefer selling where prices are higher than at farm-gate price.

Selling style is categorized as: 1) by individual, 2) middleman from outside, 3) middleman of the village, and 4) by group. Half (50%) of the farmers sell their produce individually, rather than selling to middlemen. From these results, typical marketing arrangement can be drawn: famers themselves sell their produces at the market in the district capital.

Table 1.7.1 Type of Market and Modality of Selling

Item		Selling Style					
		By individual	Middleman from outside	Middleman of the village	By group	Total	
Market Type	Market in BOMA (district capital)	169	19	3	3	194	50%
	Market near but outside the village	102	1	3	4	110	28%
	Kiosk/stand in the village	54	2	3	1	60	16%
	Along a trunk road	13	0	0	1	14	4%
	Market at provincial capital	8	0	0	0	8	2%
	Total	346	22	9	9	386	100%
		90%	6%	2%	2%	100%	

Source: JICA T-COBSI Project Team (Feb 2013)

2) Means of Transportation

Good road network and availability of transportation means are critical in the farming business. Each respondent was asked to fill out the share of each means of the 6 choices, 1) bicycle, 2) on-foot, 3) vehicle, 4) selling to middlemen, 5) motorbike, and 6) others, summing to 100%. The average share of each transportation means of the 378 valid responses (sites) is indicated in Table 1.7.2. As shown in the table, "bicycle" shares 53%, followed by "on-foot (22%)" and "vehicle (13%)." Since the major selling style is individually, farmers tend to carry their produces by themselves using bicycle or on-foot.

Table 1.7.2 Share in the Means of Transportation

Transportation	Average
Bicycle	53%
On-Foot	22%
Vehicle	13%
Middlemen	8%
Motorbike	1%
Others	3%
Total	100%
No. of Responses	378

Source: JICA T-COBSI Project Team (Feb 2013)

3) Distance and Time to Market

Distance between the site and market and the time required are summarized in Table 1.7.3 by the type of transportation. From the 382 valid responses, average distance reached 21 km; to carry the produce, it takes approximately 3 hours. In detail, distance is 23 km when using bicycle, taking 2.6 hours to reach the market. For sites 10km from the market place, on average 3.3hrs is the travel time on foot with an average speed of 3.1km/hr. In the case of vehicle, furthermore, distance reaches 41 km on average. In such, depending on the distance, farmers choose appropriate means of transportation.

Table 1.7.3 Distance and Required Time to Market

Means of Transportation	Distance		Hours		Speed Estimated (km/hr)
	Average (km)	No. of Responses	Average (hrs)	No. of Responses	
Bicycle	23	209	2.6	208	8.9
On Foot	10	108	3.3	107	3.1
Vehicle	41	40	3.2	39	13.0
Not Specified	17	25	3.8	13	4.4
Total/Average	21	382	2.9	367	7.2

Source: JICA T-COBSI Project Team (Feb 2013)

4) Frequency of Selling

Frequency of selling by a typical farmer in each scheme was addressed. Of a total of 422 valid responses, it was found that farmers sell their produces nearly 10 times each month, which is about 2-3 times per week. Comparing the modes of transportation, frequency is high with "on-foot (11.6 times) as compared to "bicycle (9.5 times)" and "vehicle (6.0 times)" per month.

Table 1.7.4 Frequency of Selling Produces

Means of Transportation	Frequency of Selling per month	No. of Responses
Bicycle	9.5	209
On Foot	11.6	108
Vehicle	6.0	40
Not Specified	9.9	65
Total/Average	9.8	422

Source: JICA T-COBSI Project Team (Feb 2013)

1.7.2 Group Activities for Marketing

1) Number of Groups and Number of Members per Group

In the questionnaire survey, it was confirmed that there are at least 83 farmer groups selling their produces as a group, having an average of 7 members per group. Usually, group selling is carried out based on the type of crop. In the survey, 12 types of crops are confirmed including tomato, cabbage, maize, and rape, most of them are cash crops traded at higher prices. As shown in Table 1.7.5, the number of groups is the largest for the group that is selling tomato (22 groups), which is followed by cabbage (13groups), and maize (10 groups).

Apparently, the number of members per group is largest in cassava group (20 farmers), which is followed by vegetable (18 farmers), and millet (13 farmers). It turned out that the number of members is relatively bigger for such crops market price is not much high or traditionally consumed.

Table 1.7.5 Number of Groups and Number of Members per Group

Crop	Number of Groups	Members per Group
Tomato	22	8
Cabbage	13	4
Maize	10	7
Rape	9	7
Green Maize	8	4
Onion	8	4
Beans	3	11
Vegetable	3	18
Cassava	2	20
Irish Potato	2	4
Millet	2	13
Groundnuts	1	4
Total	83	7

Source: JICA T-COBSI Project Team (Feb 2013)

2) Benefit Sharing among the Members

Although the number of valid responses is limited, general principle in sharing the benefit was surveyed. Of a total of 21 valid responses, 17 groups share the benefit from group selling based on the amount each farmer produced. Alternatively, there are two groups that share the benefit based on the actual benefits from selling produces of each famer. These two principles are quite similar but, if the quality of the produces is different and thus unit price differs, consequences may be different even if selling the same type of crop.

Moreover, the other two groups share the benefit equally regardless of the quality and amount of crop that each farmer produced. At first glance, it seems not much reasonable; however, it might be rational enough in such a case when the frequency of selling is high so that it is difficult to trace and keep the record how much each farmer produced. Or, if the members of the group are relatives, it may not be necessary to clarify the benefit. In addition, group selling might be carried out for the community plot—further survey would be necessary.

Table 1.7.6 Number of Groups and Number of Members per Group

How to Share the Benefit	No. of Sites
Based on the amount produced	17
Based on the actual benefits from selling produces of each farmer.	2
Equally allocate the income regardless of the type and amount of the crop each farmer produced	2
Total	21

Source: JICA T-COBSI Project Team (Feb 2013)

3) Contract Farming

Quite rare case but there are some cases of contract farming in the smallholder irrigation schemes constructed in and after the pilot project of the COBSI Study. Bestowing to a total of 379 valid responses, 11 sites acknowledged the existence of contract farming in their scheme. The type of crops they declared are: maize (4 cases), Irish potato (2 cases), tomato (1case), onion and rape (1 case), cabbage (1 case), and beans (1 case). If this is stably conducted and brings about a good benefit to the farmers, it will be a good role-model of smallholder irrigation development in the future.

Table 1.7.7 Conduct of Contract Farming

Contract Farming	No. of Sites	%
No	368	97%
Yes	11	3%
Total	379	100%

Source: JICA T-COBSI Project Team (Feb 2013)

1.8 IMPACT OF COBSI SIMPLE IRRIGATION SCHEMES

As shown in Table 1.8.1, 308 out of 363 sites (85%) acknowledged improvements after the COBSI pilot project. Using an open-ended question which asked of the major impacts by the pilot project, 685 multiple responses were obtained. The major answers in order of frequency to mention include: 1) income generation, 2) better housing, 3) better education, 4) more food, 5) being able to purchase commodities, 6) improvement of living and 7) better nutrition, refer to Table 1.8.2.

In general livelihood has improved i.e. "better housing," most of sites attested that farmers can now construct the house with iron roof or buy iron roof for existing house. It seems that the change from traditional thatched roof to iron roof is one of the significant indicators of the development. The third ranked, "better education," indicates that farmers have enough money to pay school fees for children. Related to children, better nutrition and better dressed are also the impact after generating money from the new scheme. Food security has improved as the farmers do not depend on rain fed harvest like before the irrigation scheme.

As a result families can now afford 3 normal meals per day, which was difficult before the establishment of the irrigation scheme under COBSI. It is quite interesting that vegetable cultivation is important for them not only as an income generation but home consumption too.

Those without vegetables can now afford to buy from neighbors. In fact, some responses indicate that they have reduced spending to buy vegetables after they started vegetable cultivation. It implies that there used to be not enough vegetables that residents could obtain/ eat, and therefore they had to go to buy vegetables from distant markets.

There is a particular site where *chitemene* (slash and burn agriculture) has reduced, meaning that the major farming system has transferred from rain-fed cultivation, including *chitemene*, to irrigated cultivation since they started irrigation. On the other hand, there are also some sites where farmers have invested more money on the upland farming using the income they generated from irrigated farming.

Nonetheless, there is some negative response e.g. in a scenario where there is breakage of the furrow and weir, it discourages the farmers forging ahead.

Table 1.8.1 Acknowledgement to the Positive Impact of COBSI

Improvement after COBSI	No. of respondents	%
Yes	308	85%
No	55	15%
Sub Total	363	100%
Blank	50	
Total	413	

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.8.2 Type of Positive Impact of COBSI

Rank.	Positive Impact Observed after COBSI	No. of Responses	Rank.	Positive Impact Observed after COBSI	No. of Responses
1	Income generation	100	20	Crop diversification	4
2	Better housing	98	20	Contribute to community	4
3	Better education	84	22	Able to buy vegetable nearby	3
4	More food	72	22	Increase of employment	3
5	Able to purchase commodities	55	24	Transportation fee is manageable	2
6	Improvement of living	54	24	Buy water pumps	2
7	Better nutrition	49	24	Healthier	2
8	Poverty is reduced	19	24	No need to buy vegetable	2
8	Gardening development	19	24	Irrigated cultivation needs less labor	2
10	Better dressed	16	24	Farming development	2
11	Better sales	14	30	Buy Motorbike	1
12	Cash flow	11	30	Making banana plantation	1
12	Better production	11	30	*Chitemene* decrease	1
12	Water is available	11	30	Being able to save money	1
15	Fish pond	10	30	Start new business	1
16	Buy more agricultural input	8	30	Better couple`s relation	1
17	Expansion of irrigated land	7	30	Working together among villagers	1
17	Obtain new technologies	7	30	Stop selling charcoal	1
19	Buy Livestock	6		Total	**685**

Source: JICA T-COBSI Project Team (Feb 2014)

1.9 CONCLUSION AND IMPLICATION FROM THE SURVEY

1.9.1 Impact of the COBSI Approach

1) Anticipated Pros and Cons in COBSI Approach

During the pilot project of the COBSI Study, smallholder irrigation development was implemented based on a hypothesis wherein:

1) Light weight weirs are more suitable on the flat *dambo* areas of the target provinces
2) Application of wooden structure can release farmers from too much reliance on materialistic assistance from outside
3) Simple technology enables farmers to conduct irrigation development by their own initiatives
4) Irrigation development can be boosted by developing more numbers of schemes
5) Dissemination of the technology becomes faster and wider by doing it with extension officers
6) Farmers' sense of ownership can be enriched by involving them in the construction, operation and management of the irrigation schemes
7) Applicability and sustainability of the permanent schemes can be increased by introducing them in the area where simple schemes are well managed

However, some challenges and limitations were also anticipated including:

1) Light weight structure can be easily washed away during rainy season
2) Weirs need to be re-constructed every season
3) Wooden structure may not be able to divert enough amount of water
4) Irrigable area is small and the number of beneficiaries is limited
5) Farmers dislike the way the weir works as it requires continuous maintenance

2) Impact of COBSI Approach Implied by the Survey Result

The result of the follow-up survey gave us some implications with regard to the issues listed above.

a) Durability of Simple Weirs

First, durability of the simple, wooden and light-weight structure is verified. Against the original anticipation that the weir is washed away during rainy season, it was found that about 80% of the weirs endure even during rainy season, of which 15% of the weirs "remain as it is" (Table 1.5.4). This result describes well the typical topography of the target provinces—flat and thus water flow is relatively gentle especially where simple schemes are applicable.

b) Increase in Irrigated Area

Thus far, the sustainability needs to be discussed based not only on the durability of irrigation structures but more on the outcomes in irrigated agriculture. Question is that: "whether or not farmers can operate and manage the same size of irrigated area in the long run?" In terms of the area irrigated, it was found that an average size of area per site has increased from 1.4 ha to 1.9 ha, translates to 36% of increment (Table 1.2.5), suggesting that farmers can manage and even increase the size of irrigated area without any particular assistance from outside. Note that the water potential of the water source in most of areas still surpasses the actual use (Table 1.2.7.) Thus, further development of irrigated area is possible.

c) Water Shortage at the End of Dry Season

In contrast, some challenges and limitation are also found. Even though the water potential is high enough at the diversion point, water shortage appears to be a problem at the end of dry season. In fact, 35% of the responses regarding the problems in irrigated agriculture were associated with "water shortage" (Table 1.6.14). As a result, the length of furrow decreased at

13% of the sites (Table 1.3.8). And, irrigated area decreased in about 24% of the sites (Table 1.2.4). Obviously, water leakage is one of the causes of the water shortage at the farm plots. Thus, introduction of some countermeasures is required, i.e. use of lining.

d) Sense of Ownership

It is believed that the farmers' sense of ownership or self-help attitude would show the institutional potential toward upgrading of irrigation facilities. In this regard, implementation status of maintenance works may represent the ownership. Farmers conduct maintenance works, such as cleaning, weeding and de-silting of furrow, in roughly 80% of the sites, except for the de-silting of the diversion point (58%): (Table 1.5.5).

It was learned that there are many variations on sites, having problems of water shortage for example. To be sure, quite positive outcomes are drawn from the result of the follow-up survey as a whole picture. Most importantly, it was implied that simple irrigation scheme inherits two pronouncing advantages as stated below.

First, it provides a good opportunity for farmers to develop their institutional capacity in O&M and irrigated agriculture, which is to be a preparatory stage toward more advanced irrigation development using permanent structure. For those who are in a position of assisting farmers, it is also a good procedure to identifying potential sites.

Second, simple scheme is applicable even in such a location where permanent structure is not applicable from the beginning (i.e., too flat, foundation is soft and river flow moves). In reality, such unfavorable areas—essentially represented by "*dambo*"—shares most of the land in the target provinces of Northern, Luapula and Muchinga.

1.9.2 Potential Sites for the Upgrading the Weir

1) Evaluation Procedure and Criteria

As noted, there are various factors to be considered in identifying potential sites for upgrading the weirs. Considering the type (concrete or stone masonry) and scale (up to 20 m in length and up to 5 m in height) of the weir to be dealt with in the project as well as the general circumstances of the target area in topography and hydrology, such locations are not suitable where 1) streamline of the river tends to move; 2) terrain is dambo shape, 3) and farmland is influenced by flood during rainy season. To prioritize the sites for upgrading as a first screening, the project team proposes to score all the sites based on the criteria as shown below:

Table 1.9.1 Evaluation Criteria of Existing Irrigation Schemes for Upgrading

Factor	Evaluation Criteria	
(1) Slope of Riverbank	Both riverbank are more than 20% in slope:	5 points
	One side is 10%-20% and other is more than 20%	4 points
	Both riverbanks are 10%-20%	3 points
	One side is 10%-20% and other is less than 10%	2 points
	Both riverbanks are less than 10%	3 points
(2) River Shape	Streamline tends to move	Excluded
(3) Streamline	Winding	3 points
	Straight	5 points
(4) Terrain	Hilly	5 points
	Flat land	3 points
	Dambo	Excluded
(5) Influence of Flood	Influenced	Excluded
(6) River Bed	Rocky	5 points
	Sandy	2 points
	Silt	3 points
	Stony	2 points

Factor	Evaluation Criteria	
(7) Potential Area (difference between potential and actual)	More than 5 ha	5 points
	3.0-5.0 ha	4 points
	2.0-3.0 ha	3 points
	1.0-2.0 ha	2 points
	Less than 1 ha	1 point
(8) Farmers' Association	Not yet considered (information is not tangible yet)	
(9) Number of Household	More than 50 households	5 points
	30-50 households	4 points
	20-30 households	3 points
	10-20 households	2 points
	Less than 10 households	1 point
(10) Length of Weir	Less than 10 m	5 points
	10-15 m	4 points
	15-20 m	3 points
	20-30 m	2 points
	More than 30 m	1 point

Source: JICA T-COBSI Project Team (Feb 2014)

After each irrigation scheme is given scores based on the criteria above, overall evaluation is conducted based on the formula as proposed below, which is to weigh the factors in accordance with the importance of the factor.

Final Point (P) = (1)*1.0 + (3)*0.5 + (4)*0.5 + (6)*0.5 + (7)*1.0 + (8)*1.0 + (9)*1.0 + (10)*0.5

In the kick-off training, evaluation will be done by the district TSB officers based on the criteria and formula. Thereafter, more factors are also considered such as: 1) river shape, 2) irrigation requirement, 3) water allocation among other communities upstream and downstream, and 4) cost-benefit. Then, potential sites are shortlisted.

For the final selection, field survey will be carried out by TSB officers and expert team, in which following items are to be confirmed:

1) Confirmation of water use in the communities upstream and downstream: discuss with all the stakeholders if integration of the schemes are appropriate
2) Confirmation of topographic and geological conditions: select the dam axis
3) Cross-section survey and estimation of flood level
4) Drawing of a simple ground-plan
5) Confirmation of other related items as required

2) Result of Preliminary Prioritization of Potential Sites

Based on the criteria and formula, all the 413 sites have been evaluated. First, those which are absolutely not applicable to the upgrading, corresponding to the "excluded" in the criteria, were excluded from the list, resulting in a total of 144 sites remained for further evaluation. Of a total of 144 sites, the score was calculated based on the formula indicated above. The score was then converted to a percentage to the full score, namely 35 points. The number of sites by score range is summarized in Table 1.9.2.

As shown in the table, there are only 3 sites that exceeded 60%; one each in Mpika, Mwense, and Nchelenge. As far as the data obtained through the questionnaire survey is concerned, 12 sites are with relatively preferable conditions for upgrading. There are other 89 sites which can still be candidates for further analysis. However, 43 sites are most likely not suitable for upgrading. As a provisional proposal, specification of these 12 sites with high potential is shown in Table 1.9.3.

Table 1.9.2 Number of Potential Sites by Score Range

District	Percentage to the Full Score (35 Points)						Total
	Not Suitable		Moderate		Better		
	0%-20%	20%-30%	30%-40%	40%-50%	50%-60%	60%-70%	
Kasama	3	3	1	2			9
Luwingu		3	8	1	1		13
Mbala	2	3	3	2	1		11
Mporokoso	1	2	3	1			7
Mungwi	1	3	9	1			14
Isoka			4	3	1		8
Mpika		2	8	6	2	1	19
Nakonde	2	4	12	2			20
Kawambwa		3	3	2	2		10
Mansa	2	4	4	3			13
Milenge	2	1		1			4
Mwense		1	3	5	1	1	11
Nchelenge		1	1	1	1	1	5
Total	13	30	59	30	9	3	144
	43		**89**		**12**		
	30%		62%		8%		100%

Source: JICA T-COBSI Project Team (Feb 2014)

Table 1.9.3 Specification of 12 Potential Sites

No.	District	Slope of Left Bank	Slope of Right Bank	Stream line	Terrain	River Bed	Potential Area (ha)	No. of House holds	Length of Weir (m)	Final Score	% to Max Score
1	Luwingu	10 to 20%	10 to 20%	winding	flat land	sandy	11	50	1	20	56%
2	Mbala	0 to 10%	0 to 10%	straight	flat land	silty	10	45	3	18	51%
3	Isoka	0 to 10%	10 to 20%	winding	flat land	rocky	5	30	7.7	19	54%
4	Mpika	0 to 10%	10 to 20%	winding	hilly area	rocky	75	73	6	21	60%
5	Mpika	more than 20%	10 to 20%	winding	hilly area	rocky	4	8	5	18	51%
6	Mpika	10 to 20%	0 to 10%	straight	hilly area	stony	10	38	4	20	56%
7	Kawambwa	0 to 10%	10 to 20%	winding	hilly area	stony	5	20	7	20	56%
8	Kawambwa	0 to 10%	0 to 10%	winding	flat land	Sandy	36	135	3	18	50%
9	Mwense	10 to 20%	more than 20%	straight	flat land	rocky	1	56	0	18	50%
10	Mwense	10 to 20%	more than 20%	winding	hilly area	Sandy	12	21	3	22	61%
11	Nchelenge	more than 20%	more than 20%	winding	hilly area	sandy	5	23	2.6	23	64%
12	Nchelenge	0 to 10%	0 to 10%	straight	flat land	sandy	28	30	1.3	18	50%

Source: JICA T-COBSI Project Team (Feb 2014): Note: Max score is 35 points.

SURVEY ON THE EXISTING PERMANENT IRRIGATION SCHEMES

SURVEY ON THE EXISTING PERMANENT IRRIGATION SCHEMES

1.1 BACKGROUND

During the COBSI Study between 2009 and 2011, 8 permanent irrigation schemes were developed. To understand the impact after the pilot project of the COBSI Study, a Follow-up survey on the permanent irrigated schemes was implemented by T-COBSI project team. The survey was implemented with JICA experts and TSB provincial officers in Kasama, using a questionnaire attached.

The 8 permanent scheme sites had been developed by 2011, namely Malashi site in Mpika of Muchinga province, Nseluka site in Mungwi district, Chaiteka site in Lungwi district, Chilala site and Kasonde site in Mporokoso districts of Northern Province, and Mwiliwa site and Kakose site in Mansa district of and Chibolya site in Kawambwa district of Luapura province (See the location map below). The structure is either concrete wall type or wet-masonry type, and one earth dam. Site name, membership, and design type of the diversion weir, irrigated area are summarized Table 1.1.1

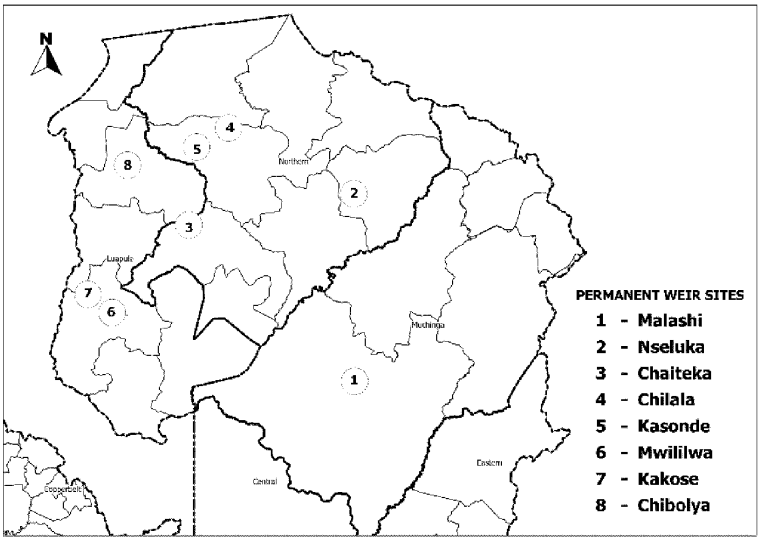


Figure 1.1.1 Location Map of Eight Permanent-Wier Schemes Developed in COBSI Pilot Project
Source: JICA T-COBSI Project Team

Table 1.1.1 Profile of Permanent Weir Schemes Developed in the COBSI Pilot Project

Province/ District	Site name Club name	Membership Village concerned	Irrigated area (ha)	Type of permanent structure Dimension
Muchinga Province				
Mpika	- Malashi Site - Ubulini Tabupwa Farming Group	- 2010: 20 - 2013: 30 - Chisowa-A - Chisowa-B - Chiponya	- 2010: 7.9 ha - 2013: 11.25 ha - Designed: 10.5 ha - Potential: 30 ha	- Concrete - Height: 2.3 m - Length: 15.0 m
Northern Province				
Mungwi	- Nselka Site - Kalungu vegetable and saving group	- 2010:36 - 2013: 36 - Kasonde - Wapata - Chapewa - Washanga	- 2010: 6.0 ha - 2013:3ha[1] - Designed: 8.0 ha - Potential:8.25ha	- Concrete - Height: 1.8 m - Length: 12.5m
Luwingu	- Chaiteka Site	- 2010: 25	- 2010: 3.0 ha	- Stone Masonry

[1] Irrigated area has been downsized because of main 3 reasons. Firstly, some members dropped out from maintaining irrigated land with a lack of agricultural inputs. Secondly, headman`s involvement affected to allocate the irrigated land and he threatened members to maintain the irrigated land, Thirdly, none-function of irrigation scheme committee because of the conflicts over leadership. As a result, some people dropped out from irrigation. As shown in the table, the number of memberships between 2010 and 2013 has not changed; however because of the above reasons there is possibility that the number was actually decreased.

Province/ District	Site name Club name	Membership Village concerned	Irrigated area (ha)	Type of permanent structure Dimension
	- Milandu Irrigation Group	- 2013: 50 - Chaiteka - Milandu	- 2013: 8.75 - Designed: 5.0 ha - Potential: 26.25 ha	- Height: 2.0 m - Length: 12.0 m
Mporokoso	- Chilala Site	- 2010: 36 - 2013: 23 - Chilala	- 2010: 3.3 ha - 2013: 3.5 ha - Designed: 5.0 ha - Potential: 45 ha	- Stone Masonry - Height: 1.6 m - Length: 13.0 m
Mporokoso	- Kasonde Site - Kayokolo Farmers Group - Chilangwa Farmers Scheme	- 2010: 63 - 2013: 38 - Kasonde - Chilangwa	- 2010: 1.25 ha - 2013: 1.50 ha - Designed: 5.0 ha - Potential: 10.0 ha	- Stone Masonry - Height: 1.4 m - Length: 15.0 m
Luapula Province				
Mansa	- Mililwa Lower Site - Mililwa Lower Group	- 2010:15 - 2013: 40 - Timoth - Chibolya - Chakulya - Kashikishi - Mutiti	- 2010: 1.25 ha - 2013: 15.0 ha - Designed: 3.0 ha - Potential: 25 ha	- Earth Dam - Height: 4.0 (2.4) m - Length: 75 (32.0) m (before improvement by GRZ)
Mansa	- Kakose Site - Tubombele Pano	- 2010:15 - 2013: 20 - Kakose	- 2010: 2.0 ha - 2013: 4.0 ha - Designed: 5.0 ha - Potential: 20 ha	- Concrete - Height: 1.8 m - Length: 41m
Kawambwa	- Chibolya Site - Luena Irrigation Club	- 2010: 4 - 2013: 10 - Chibolya - Spinoti	- 2010: 3.2 ha - 2013: 1.75 ha - Designed: 5.0 ha - Potential: 26 ha	- Stone Masonry - Height: 1.8 m - Length: 24.0 m

Source: JICA T-COBSI Project Team (Feb 2013)

1.2 GENERAL CONDITION

1) Number of Scheme Members

The number of member increased in 5 sites (Malashi, Chaiteka, Miliwa, Kakose,Chibolya), decreased in 2 sites (Chilala, Kasonde) and remained the same in 1 site (Nselka[2]). The reason attributing to increase of members includes: the furrow length being extended (Miliwa), increase in water quantity (Chaiteka,miliwa), and increase in irrigable area (Kakose), improved road condition (Kakose). Decrease in membership on the mentioned sites is due to: the weir was broken and furrow has not crossed the road because of a lack of culvert (Kasonde); and poor soil fertility discouraged farmers to invest (Chilala).

Table 1.2.1 Number of Scheme Members

Site	Year Establish -ed	Initial (When Constructed)				Present (2013)				Comparison	
		House hold	Population			House hold	Population			Increase Rate of HH Numbers	Up/ Down
			Total	Women	Men		Total	Women	Men		
Malashi	2002	20	160	90	70	30	240	130	110	150%	↑
Nselka	2009	36	250	140	110	36	280	150	130	100%	=
Chaiteka	2009	25	200	130	70	50	400	250	150	200%	↑
Chilala	2010	36	324	180	144	23	207	120	87	64%	↓
Kasonde	2009	63	315	210	105	38	190	120	70	60%	↓
Miliwa	2009	15	105	50	55	40	400	220	180	267%	↑
Kakose	2006	15	60	35	25	20	80	45	35	133%	↑
Chibolya	1996	4	28	15	13	10	66	40	26	250%	↑
Max.	2010	63	324	210	144	50	400	250	180	267%	
Min.	1996	4	28	15	13	10	66	40	26	60%	
Average	2006	27	180	106	74	31	233	134	99	153%	

Source: JICA T-COBSI Project Team (Feb 2013)

[2] Population of member which includes family member has increased even the number of household decreased.

2) Number of Actual Irrigators

The number of actual irrigators is sometimes different from the members who are just registered in the membership of the scheme. The number of actual irrigator increased in 4 sites (Malasi, Chaiteka, Miliwa, and Kakose) and decreased in 3 sites (Nselka, Chilala, and Kasonde) and remained the same in one site (Chibolya).

Increase in production backed up by the increased market demand and buyers visiting (Chaiteka) are some of the factors leading to an increase in the number of irrigators. Furthermore, new members and expansion of command area (Miliwa), increase of population (Kakose), expansion of furrow length (Kakose), and high demand for banana (Kakose) are disclosed. As for Kasonde site, the furrow construction has halted to cross the main road to the other command area; this has demotivated farmers, hence the decrease in the number of irrigators.

Table 1.2.2 Number of Actual Irrigators

Site	Year Establi-shed	Initial (when established/improved)				Present				Comparison	
		House hold	Population			House hold	Population			Increase rate of HH numbers	Up/ Down
			Total	Women	Men		Total	Women	Men		
Malashi	2002	20	160	90	70	30	240	130	110	150%	↑
Nselka	2009	33	230	135	95	20	140	85	55	61%	↓
Chaiteka	2009	25	200	130	70	35	280	175	105	140%	↑
Chilala	2010	36	324	180	144	12	108	60	48	33%	↓
Kasonde	2009	15	125	70	55	12	60	40	20	80%	↓
Miliwa	2009	10	38	15	23	30	150	75	75	300%	↑
Kakose	2006	10	25	10	15	25	100	45	55	250%	↑
Chibolya	1996	4	28	15	13	4	18	7	11	100%	=
Max.	2010	36	324	180	144	35	280	175	110	300%	
Min.	1996	4	25	10	13	4	18	7	11	33%	
Average	2006	19	141	81	61	21	137	77	60	139%	

Source: JICA T-COBSI Project Team (Feb 2013)

3) Assistance from Donors

Among 8 sites, 3 sites have received some assistance from some donors as listed below.

Table 1.2.3 Assistance/Aid by Donors

Site	Year	Aid	Amount
Nselka	2010	Fertilizer D-Compound/Urea& seed Support By ASP(Agricultural Support Program of Swedish Aid)	---------
Miliwa	2013	Permanent weir was paved to strengthen By GRZ	K118,000
Chibolya,	2013	Bridge construction By DANIDA(Danish Development Agency)	K136,000
	2004	Health Post By CDF (Constituency Development Found)	K2,800

Source: JICA T-COBSI Project Team (Feb 2013)

4) Water Use in COBSI Scheme, Upstream, and Downstream

A survey on the water use along the main river/stream was conducted: how the water is being used in the scheme as well as upstream/downstream of the scheme, namely inside of COBSI scheme, upper stream of COBSI scheme—upper than permanent weir, and downstream—lower than permanent weir). The categories surveyed on are: 1. irrigation, 2. drinking, 3. cooking, 4. washing dishes, 5. washing clothes, 6. fishpond, 7. cattle, and 8. other activities.

Inside the scheme, the results of the survey are shown in Table 1.2.4. The most of activities listed are implemented in the site: brick molding (5 sites), fish farming (3 sites), and bathing and soaking cassava are also implemented among 8 sites. Brick molding, which needs more quantity of water, is implemented most of the schemes. This is due to the fact that permanent schemes have more availability of water than

others.

Table 1.2.4 Water Use in COBSI Scheme

Site	In COBSI scheme							
	1	2	3	4	5	6	7	8
Mpika (Malashi)	✓	✓	✓	✓	✓		✓	Brick Molding
Mungwi (Nselka)		✓	✓					
Luwingu (Chaiteka)	✓	✓						
Mporokoso (Chilala)	✓	✓	✓	✓	✓	✓	✓	Brick Molding, Fish Farming
Mporokoso (Kasonde)	✓	✓	✓	✓	✓	✓		Brick Molding Fish Farming
Mansa (Miliwa)	✓			✓	✓	✓		Brick Molding Bathing
Mansa (Kakose)	✓	✓	✓	✓	✓	✓		Soaking Cassava, Fish Farming
Kawambwa (Chibolya)	✓	✓	✓	✓	✓	✓		Brick Molding
TOTAL	7	7	6	6	6	5	2	

Source: JICA T-COBSI Project Team (Feb 2013)

Note: 1. irrigation, 2. drinking, 3. cooking, 4. washing dishes, 5. washing clothes, 6. fishpond, 7. cattle, and 8. other activities

As shown in Table 1.2.5 and Table 1.2.6, 6 sites in upper stream have irrigation activities which may affect water quantity of main river or stream. On the other hand, 3 sites have irrigation activities downstream. This result is expected as the water quantity may not be enough for downstream to irrigate activities, unless the lower area have other stream to intake water. Many factors may be considered as to why there are less irrigation activities. It is important that at the permanent weir uses care considering that farmers downstream are not deprived of irrigation water.

Table 1.2.5 Water Use in Upstream

Site	Upper stream (upper than weir)							
	1	2	3	4	5	6	7	8
Mpika (Malashi)	✓	✓	✓	✓	✓		✓	Brick Molding
Mungwi (Nselka)		✓	✓	✓	✓			
Luwingu (Chaiteka)	✓	✓						
Mporokoso (Chilala)		✓	✓	✓	✓			Fish Farming
Mporokoso (Kasonde)	✓	✓	✓	✓	✓			Brick Molding Fish Farming
Mansa (Miliwa)	✓			✓	✓	✓		Soaking Cassava,
Mansa (Kakose)	✓	✓	✓	✓	✓			Soaking Cassava, Fish Farming
Kawambwa (Chibolya)	✓	✓		✓	✓			
TOTAL	6	7	5	7	7	1	1	

Source: JICA T-COBSI Project Team (Feb 2013)

Note: 1. irrigation, 2. drinking, 3. cooking, 4. washing dishes, 5. washing clothes, 6. fishpond, 7. cattle, and 8. other activities

Table 1.2.6 Water Use in Downstream

Site	Downstream (lower than weir)							
	1	2	3	4	5	6	7	8
Mpika (Malashi)							✓	
Mungwi (Nselka)		✓	✓	✓	✓	✓		
Luwingu (Chaiteka)	✓	✓	✓	✓	✓			
Mporokoso (Chilala)		✓	✓	✓	✓			Fish Farming
Mporokoso (Kasonde)								
Mansa (Miliwa)	✓			✓	✓	✓	✓	Goats/Pigs / Soaking Cassava
Mansa (Kakose)		✓	✓	✓	✓			
Kawambwa (Chibolya)	✓	✓	✓	✓	✓	✓		Brick Molding
TOTAL	3	5	5	6	6	3	2	

Source: JICA T-COBSI Project Team (Feb 2013)

Note: 1. irrigation, 2. drinking, 3. cooking, 4. washing dishes, 5. washing clothes, 6. fishpond, 7. cattle, and 8. other activities

5) Issues/ Constraints to Irrigate Planned or Potential Area

There are many issues/constraints for farmers not to be able to irrigate the planned or potential area. Water leakage from furrow is serious constraint among almost all 8 sites because the furrow is vulnerable due to earth lining. The specific issues among 8 sites are shown in Table 1.2.7.

Table 1.2.7 Issues/ Constraints to Irrigate Planned or Potential Area

Site	Issues/constraints
Malashi	Water shortage because of water stealing in upper canal.
Nselka	Limitation of manpower for potential area cultivation Lack of agricultural input
Chilala	Lack of manpower, Lack of soil fertility, High cost of fertilizer (dry season), farmers are more used to do *Chitemene* than irrigation.
Kasonde	Furrow construction is stopped by the main road.
Miliwa	More water is lost through the spillway/ Water leakages along the furrow/ De-silting of the pond to allow spring water pond/Additional outlet at the centre of the dam to allow water to pass.
Kakose	High seepage along the furrow
Chibolya	Right side abutment was washed away/Seepage along the furrow/ Lack of input such as fertilizer, seed and pesticides.

Source: JICA T-COBSI Project Team (Feb 2013)

1.3 CONDITION OF THE IRRIGATION FACILITIES

1.3.1 Abstract of Condition for Eight Permanent Weirs

It is important to factor in the flood situation in the design of weir; attention to this is brought in by the prevailing situation of the weir where a part of stone masonry was destroyed by a flood. In some other schemes, it was observed that quality of stone masonry is not so good. Especially, stone masonry at the lower end of slope is sometimes defective. This is considered that mortar of stone masonry at lower end of the slope was washed away by water during the construction. De-watering during the construction also should be carefully executed.

Condition of furrow is generally fair to good. Length of furrow was extended in 4 schemes. Erosion along the furrow is observed in 4 schemes. This is because the wall of the furrow is too steep. Water leakage is observed in 7 schemes and it is one of major problems in those schemes. It is observed in many cases at just downstream of the weir, sandy soil area and *dambo* area. Most of the schemes want to improve furrows. Generally, there is enough water quantity at the intake. Therefore, if water leakage reduced, they can expand the irrigated area.

1.3.2 Details of 8 Permanent Weirs

Following summarize the specification and current situation of the eight schemes. Location map of each scheme is also attached in Figure1.1.1.

Malashi Site, Mpika District, Northern Province

Weir (concrete): Length: 15.0m, Height: 2.3m, width of top: 0.6m (natural diversion channel)
Intake (concrete): Top Width: 1.1m, Bottom Width: 0.6m, Depth: 0.7m
Furrow (earth): Length: 5km, Width: 0.95m, Depth: 0.6m (300m from the weir)

Condition of concrete is good without cracks. The furrow passes along a hillside supplying water to the field from just downstream of the weir, passing Chisowa village at about 2 km from the weir, crossing a road at 3km from the weir and reach to Chiponya area. Due to water shortage and blocked road culvert, water is not being supplied to Chiponya area. There are a lot of water leakages along the furrow due to rat holes. Water flow quantity is enough (approximately 34 liter/second at 300 m from the weir) even in dry season. However, it is considered not enough to supply water to the whole potential area. The furrow needs to be improved to supply water to the whole potential area. The road culvert should be maintained. Thickness of sediment of furrow at 300 m from the weir is about 20 cm and it is not much a problem.

Regular maintenance is enough to improve it.

Nseluka Site, Mungwi district, Northern Province

Weir (concrete):	Length: 12.5m, Height: 1.8m, width of top: 0.62m
Intake (stone masonry):	Width: 0.7m, Depth: 0.6m
Furrow (earth):	Length: 4km, Width: 1.0m, Depth: 0.3m
Flash Gate (Stop Log):	Width: 0.66m, Depth: 0.77m

Condition of concrete is fair. According to impact test by a hammer, some parts of concrete weir are not well compacted. Stone masonry at the bottom of slope protection is deteriorated. Mortar of stone masonry is washed away. This is because de-watering during construction of stone masonry was not enough.

The furrow has a lot of water leakage due to rat holes. The section of furrow crossing dambo area is sometimes destroyed by flashing water in the rainy season. The farmers are constructing a dam to protect the furrow. Water flow quantity of the furrow is about 10 liter/s at upstream part of the furrow. This quantity seems not enough to irrigate the potential area. However, water flow quantity of the stream is about 80 liter/s and it is enough for whole potential area if water leakages are reduced. The farmers plan to extend the furrow to 0.8 km.

Chaiteka Site, Luwingu District, Northern Province

Weir (stone masonry):	Length: 12.0m, Height: 2.0m, width of top: 0.6m
Intake (stone masonry):	Width: 1.1m, Depth: 0.55m
Spillway (stone masonry):	Upper part width: 1.42m, upper part height: 0.38m, Lower part width: 0.65m, lower part height: 0.45m
Furrow (earth):	Length: 8km, Width: 0.8m, Depth: 0.2m (150m from the weir)

Condition of stone masonry weir is good. Small part of stone masonry for river bed at downstream of spillway is damaged but it is not so much problem because of bed rock. The furrow pass through a dambo area for about 300 m after the weir, and discharge water to upper field area, then pass another dambo area for about 500 m and reach to the lower field area. There are a lot of water leakages in the dambo area especially within the section about 100 m of furrow after the weir. Water flow quantity is enough (approximately 20 liter/second on upper field areas) and it reaches to the end of furrow even in dry season. However, it is considered not enough to supply water for whole potential area. The furrow needs to be improved to supply water to the whole potential area. The road crossing part of furrow is often filled with sediment in rainy season. It requires only annual maintenance.

Chilala Site, Mporokoso District, Northern Province

Weir (stone masonry,):	Length: 13.0m, Height: 1.6m, width of top: 0.77m
Intake (stone masonry):	Width: 0.95m, Depth: 0.6m
Furrow (earth):	Length: 4km, Width: 1.0m, Depth: 0.4m

Condition of stone masonry is good, having no cracks and no water leakage either. Condition of furrow is fair. There is comparatively much water leakage at upstream part of furrow. However, water flow quantity is enough (approximately 42 liter/second at upstream area) even in dry season. Water flow quantity of the river is enough to supply water to the whole potential area. Some part of the furrow needs to be adjusted on the elevation or realignment. The bridge over the furrow needs to be improved.

Kasonde Site, Mporokoso District, Northern Province

Weir (stone masonry,):	Length: 8.0m, Height: 1.4m, width of top: 0.6m
Intake (stone masonry):	Right : Width: 0.8m, Depth: 0.4m Left: Top Width: 0.75m, Bottom Width: 0.4m, Depth: 0.35m
Spillway (concrete):	Width: 0.6m, Depth: 0.7m

Furrow (earth): Length: Right: 200m, Left: 200m,

The headraces for both sides of the intake are destroyed at just downstream of the weir. Stone masonry of both sides of the river bank is destroyed. This is because stone masonry at the river bed was not constructed properly, soil was absorbed, and stone masonry cracked and got destroyed. Material of stone masonry is flat stone and the thickness is not enough. Therefore, it was not durable against flood water flow. The excavation of both furrows (right and left) were done up to the road crossing only about 200 m. They are not maintained as they are not in use.

Water flow quantity of *Kasakalabwe* River is rich (approximately 330 liter/second) even in dry season. This is considered enough to supply water for whole potential area. If the weir will be repaired and the road crossings (culvet) are constructed, and the furrows are excavated, more than 10 hectares will be irrigated.

Mililwa Lower Site, Mansa District, Luapula Province

Earth dam: Length: 75.0m, Height: 4.0m, width of top: 2.5m
Upstream surface protection: stone masonry (thickness less than 20cmm)
Intake (gate valve): Diameter: 140 mm
Capacity of reservoir: Approximately 2,500 m3
Furrow (earth): Length: 1.5km, Width: 0.7m, Depth: 0.4m

Condition of dam body is fair. There are many cracks on the surface protection of the stone masonry. Width of some of them is 3 mm and need to be repaired. Slope of upstream and downstream of the dam is steep as 1:1. It is one of the reasons for cracks. It is recommended to make the slope 1:1.5 with additional embankment. Sediment in the reservoir is about 1 m. Seepage of water is observed at lower end of slope at the center of the dam. It is not clear whether the seepage comes from the dam or surrounding dambo. It needs to be observed continuously.

Water flow quantity of the river was almost 0 as of October 1st, 2013. According to the farmers, they could irrigate until September. The farmers want to expand the capacity of the reservoir to irrigate in October and November. To do so, detailed irrigation planning with water balance analysis is required. Furrow has been extended to 1,500 m but the road crossing has not been constructed. Water is once discharged to the stream at the bridge and introduced to the furrow again.

Kakose Site, Mansa District, Luapula Province

Weir (buttress type, concrete): Length: 41.0m, Height: 2.8m, width of top: 0.7m
Intake (stone masonry): Width: 2.5m, Depth: 1.0m
Flash Gate (Stop Log): Width: 2.0m x 2 locations
Furrow (earth): Length: 1.7km, Width: 0.6m, Depth: 0.5m

Condition of concrete is not so good. There are some cracks and honeycombs. Water leakage from the weir body is observed. There is a lot of water leakage at flash gate (stop log) but it is not much problem.

There are a lot of water leakages at just downstream of intake. The right side (river side) wall of the furrow is incomplete. Embankment for the wall should be constructed. The furrow was destroyed by a flood at about 50 m from the weir and the farmers realigned and excavated diversion furrow a stretch of about 70 m. Water flow quantity of the river is more than 1,000 liter/s and water flow quantity at intake is about 400 lit/s. However, it is about 24 liter/s near the field. It is enough for the whole area with good water management.

Chibolya Site, Kawambwa District, Luapula Province

Weir (concrete): Length: 24.0m, Height: 1.8m, width of top: 1.05m
Intake (concrete): Width: 0.7m, Depth: 0.6m
Furrow (earth): Length: 1.2km, Width: 1.0m, Depth: 0.3m

Due to floods, right abutment was washed away for 5 m. Weir itself is not destroyed. It is considered that, temporary diversion river in the right side bank was not backfilled and during the flood time, water concentrated to it and eroded the right abutment. Farmers constructed temporary weir at the right abutment and utilizing the permanent weir. There are a lot of water leakages from the temporary weir. Condition of concrete is good. There are small cracks on the surface of the concrete. Small amounts of water leakages were also observed on the weir body.

Water flow quantity in the river is about 400 liter/s and water flow quantity at intake is about 220 lit/s. However, it is about 10 liter/s near the field. If the furrow is improved, the whole potential area can be irrigated. There is a temporary weir for Kalembwe Scheme 400 m downstream of the Chibolya weir introducing water to the right side area of Luena River. It is recommended that the weir be repaired on the right abutment and construct a intake for right side of the river and thus utilize the weir for two schemes.

1.3.3 Irrigation groups

1) The Year Irrigation Group was Organized

In six of eight permanent sites, irrigation groups were organized during COBSI project. However, 2 of the sites started organizing the groups before the conduct of the pilot project. These 2 institutions, namely Malashi site in Mpika district of Muchinga province and Kakose site in Mansa district of Muchinga province were established when they started irrigation scheme by themselves.

2) Committee Member of Irrigation Scheme:

The average number of committee members per irrigation group is 7.75, thus 4.75 males and 3.00 females among the 8 permanent weirs.

3) The Procedure to Choose Committee Members

When it comes to choosing committee members, at 5 of the 8 sites, committee members were elected by the irrigation group members. And 2 of 8 sites, committee members were chosen by the representatives of villages in the scheme. On one site, the members were not selected by anyone but on voluntary basis.

4) Role of Each Member in Their Village

The committee of irrigation group is composed of chairperson, vice chairperson, secretary, vice secretary, treasurer, trustee and ordinary members[3]. In order to understand if these members have any other social status in village/community, each committee member was asked of their other role in their village/community.

Other role of chairperson: in 6 sites of 8 sites, the chairperson has other role/s in their village, such as village committee member, chair of cooperative group, village headman (2 sites) and district committee union. The chairperson in Kasonde has plural roles as chairperson of cooperative society and chairperson of neighborhood health community.

Other role of vice chairperson: in Chibolya site, the vice chairperson is a member of child health promotion.

Other role of secretary: from 4 sites secretaries take up other roles, such as member of church **society, village secretary, participant of Area Development Program and secretary of World** Vision, and lastly village productivity member.

[3] Noted that ordinal member in committee member is member who work as member of committee. Thus they are different from irrigation group member.

Other role of treasurer: Treasurers in 2 sites have other role in the care given group and chairperson of women club.

Other role of members: From 2 sites, ordinary members take other role/s, such as treasurer of church and village productive committee secretary.

As a whole, it seems that chairpersons have been chosen due to higher social status in village/ community and the other important role they take up in their village/community.

5) Registration of the Group

Only one of 8 institutions is registered. The other 7 sites even do not know the advantage of having their committee registered. Nseluka site in Mungwi district of Northern Province is the site, whose group was formed and registered in 2005 as Kalungu vegetable and saving group before the group for irrigation was formed under COBSI project. They registered to open bank account. They are now saving money from the profit of selling vegetables.

6) Water Rights

Water right is obtained from the then Ministry of Mines Energy and Water Development. Of the 8 sites, only 2 sites have water right on their scheme. Some sites are uncertain about the status of registration because they have not visited the district office to confirm the completion and status of the application.

7) Written Rules/Regulations

Only 5 of 8 sites have written rules/regulations. In 4 of the 5 sites, the rules were prepared by the members while in the other site rules were compiled by the village committee.

8) Periodical Committee Meeting

Frequency of committee meetings ranges from twice a month, monthly, 3 times per year and 4 times per year. Of the 8 sites, only 6 sites hold these meetings. The other 2 sites do not hold meeting currently because of the non-functionality of irrigation group (Malashi site in Mpika district, Kasonde site in Mporokoso district). In Malashi, the conflict between upper stream and downstream farmers is the reason for non-functionality of these irrigation groups.

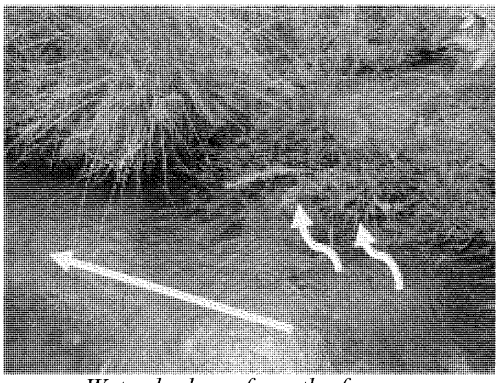
9) Periodical Group Member Meeting

Apart from committee member meetings which are the authorities of irrigation group, most of the sites hold irrigation group member meeting, of which all members are expected to participate. It was discovered that with the exception of Malashi site of Mpika, the other 7 sites have periodical meeting. Some of the issues discussed at these meetings include: water usage, furrow maintenance and cultivation. Most of the sites hold group member meeting and committee meeting separately. Group member meeting sometimes include activities such as cleaning and repair work.

10) Problems Faced

These permanent schemes face several problems, such as water leakages on the facilities, water distribution problem and conflicts with the upper stream users. Water leakage from furrow is one of the main issues especially in Chilala site, Mporokoso district, which is also mentioned 1.3.2. As of irrigation facilities, there are serious seepages upper stream of canal as shown in photo.

Serious water shortage was reported from Nseluka site of Mungwi district as described in 1.3.2. They are now expanding the furrow length; however the new furrow was dug against gravity direction in order to cover for all member plots, as a consequence water flow has stopped at halfway of the total length. Besides the serious water leakage problem, this matter has caused a serious water shortage. JICA team is planning to help to direct the farmers the right way of digging furrow in the next phase.



Water leakage from the furrow (Chilala Site, Mporokoso District)

Water distribution among members is also a crucial issue for them. Two (2) sites faced water distribution problem. In Chaiteka site of Luwing district, member's children tend not to close the furrow properly after opening to induce water into their plots. As a result, there is water shortage downstream of furrow. They discussed this matter in periodical member meeting and solved it with their parents teaching children to be careful about it.

Serious conflict with upper stream users is occurring in Malashi site of Mpika district, there is a significant water steal problem in their upstream area and currently no water flow to the area of irrigation group(detail is described in the box hereunder).

Furthermore, the lack of cooperation from local government causes serious problem. Kasonde site of Mporokoso district, the weir, especially headraces of both side intakes and both side of river bank were destroyed. Currently no beneficiaries use the furrow from this weir. The problem is the furrow, which was dug by members since the weir was constructed, was stopped by main road and could not pass the main road (need for road culvert).

Although local officers and district office were expected to deal with this matter, they have not dealt with this problem until now. According to the member, the flood occurred during rainy season after these furrows were dug by the members up to the main road; water was over flowed around potential road crossing point as illustrated on the map.

At the same time, flood occurred around the weir site. The strong water pressure caused serious damage to the weir and furrow. Since then, the permanent weir and furrows have been non-functional. The irrigation group and its committee are not functioning too. Only the temporally weir, which was constructed before permanent weir was constructed, is working well and contributed to expansion of irrigated area.

From these scenarios, it is easy to understand the importance of cooperation from local office, physically and financially for the maintenance of the scheme. On the other hand, temporary weir has an advantage, in which farmers can

Focus Topic on Water Conflict
- Case Study in Malashi site -

In Malashi site of Mpika district, the committee number of the irrigation group has been increased from 20 farmers in 2002 when the committee established to 53 when the permanent weir was constructed. However, the number was decreased to 30 by 2013. This is because members of Chisowa-B village and Chiponya village dropped out from the irrigation group due to the shortage of water. The shortage was caused by unpermitted use of the water by villagers of Chisowa-A village, which is located in the upper stream of furrow.

This happened after the permanent weir construction in 2011 with upgrading from temporary one. Since Chisowa-A is located in the upper area. Despite being invited to participate in the activities before construction they were not interested in participating. According to the members, who are mostly villagers from Chisowa-B located in the middle part of furrow, after villagers from Chisowa-B were able to enjoy their fruitful irrigation area, villagers from Chisowa-A started to irrigate the water without either paying membership fee nor joining the institution`s activities.

The members tried to sue unauthorized users with the coordination of MAL, police and chief. After the duration of arresting the stealers by their chief, the stealer told the members that they would charm the members if they continue complaining about water use. It seems that witchcraft in Chisowa-A is so powerful, according to villagers. Since then, the members are scared of being bewitch and thus more and more people dropped out from the member.

Until now, the water is stopped on the borderline between Chisowa-A and Chisowa-B villages, and member of Chisowa-B and Chiponya cannot even get a drop of water from the line. People are now doing bucket irrigation while the villagers in Chisowa-A use plenty of water for their irrigated land and as well as molding blocks.

maintain it by themselves without specific technique and large financial support from outside.

11) Acceptance of New Member to Irrigation Group

It is important to know the situation for new member acceptance at the site in order to expand irrigate land efficiently. As a result of this research, it was learnt that 6 of the 8 sites accept new member from either insider or outsider the village. Membership fee was confirmed as a condition for joining, in the 5 sites. In case where they originate from an outside village, an introductory letter for the applicant from the village of origin is requested, which is decided at the village meetings. Some villages do not ask formal letter in case people know each other well.

Table 1.3.1 Membership Fee and Other Conditions for the New Members

Site	Membership fee and other conditions
Malashi site, Mpika district	Request K150 membership fee to both insider and outsider
Nselka site, Mungwi district	Request K200 membership fee to both insider and outsider
Chaiteka site, Luwingu	Request K100 membership fee to both insider and outsider
Chilala site, Mporokoso district	For both insider and outsider: Normally not accept however one exception exists. He needed to bring formal letter from his original place and he was assessed through village meeting. He need to move in the site and take responsibility as villagers.
Kasonde site, Mporokoso district	Not accepted by permanent scheme site because of none function. Only temporally weir site welcomes new member.
Miliwa sites, Mansa district	For insider, request K10.00 membership fee, For outsider, request K15.00 membership fee
Kakose site, Mansa district	For insider, request them to participate in all works on furrow maintenance. Outsider is not accepted.
Chibolya site, Kawambwa	For insider, request K2.5 with formal letter, obligation to join maintenance work. Outsider is not accepted.

12) Allocation of Land for New Member

Regarding the allocation of land to new members, 2 sites responded that it is upon the landowners to individually discuss with the newcomer, and the other 2 sites response was that "new members are allocated quarter lima from the irrigation group."

1.4 OPERATION AND MAINTENANCE

Water allocation: 5 sites implement rotation when they distribute water to each plot; 2 sites have no rules for distribution; one site is using bucket irrigation; and the other site is "discussed by neighbors when they need water."

Water control for distribution: 7 out of 8 sites open and close a cut-out at the furrow when they control water; and one site is using pipe to intake water into individual plot (Malashi site).

Manual for the operation and maintenance: No site prepares the manual for operating irrigation systems.

Daily operation and maintenance activities: as shown below.

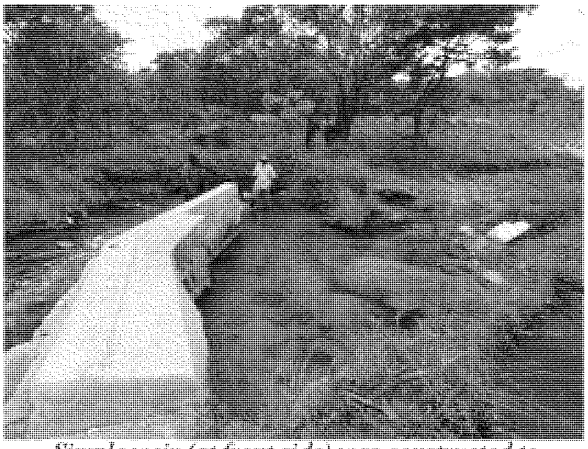
Table 1.4.1 Daily operation and maintenance activities

Site Name	Check water flow at the weir	Patrol along furrow	De-silting at upstream of weir	De-silting of furrow	Cleaning /weeding of furrow	Repair of weir	Repair of furrow
Malashi	2 times / week	2times / week	1 time / year	2 times / week	2 time / week	NO	1 time / month
Nselka	2 times / month	3 times / week	1 time / year	2 times / year	1 time / year (April)	NO	1 time / month
Chaiteka	1 time / week	1 times / week	1 time / week	1 time / year	1 time / year	NO	3 times // week
Chilala	2 times / month	2 times / month	1 time / month	1 time / yearn	1 time / year	NO	1 time / month
Kasonde	1 time / week	1 time / week	1 time / month	NO	NO	NO	??
Mililwa	1 time / week	1 time / week	N/A	1 time / week	1 time / month	NO	1 time / month

Site Name	Check water flow at the weir	Patrol along furrow	De-silting at upstream of weir	De-silting of furrow	Cleaning /weeding of furrow	Repair of weir	Repair of furrow
Kakose	1 time / week	1 time / week	N/A	N/A	1 time / month	NO	When necessary
Chibolya	1 time / week	2 times / week	1 time / month	1 time / year	2 times / year		1 time / year

Source: JICA T-COBSI Project Team (Feb 2013)

It is quite significant that almost all the sites carry out all maintenance works daily except for repairing of weir. This is because extension workers are in charge of checking the condition of permanent weir for high technical level. In Chibolya site, the right bank of concrete weir was washed down and members built temporary weir to reserve water as shown in the photo (right). Therefore they maintain the temporary weir which is part of permanent weir daily.



Simple weir (at front side) was constructed to reserve water (Chibolya Site, Kawambwa)

Regarding the furrow maintenance, most of the sites carry out maintenance works often. As for de-silting works on both the reservoir and furrow, they tend to de-silt daily and some site gather all member to clean the furrow and weir just after rainy season. In Kasonde site, the weir is broken and furrows are stopped by main road going through their village. Therefore, there are many blank gaps.

1.5 GENDER

1) Work Roles by Gender

Regarding the work role between women and men, there are significant differences between weir construction and material gathering for its construction. Male members are mainly working on construction of the weir, while female members mainly gather materials for construction of weir. In the interview, members answered that male member tend to join laborious work and female members tend to support male member without bringing heavy materials.

Table 1.5.1 Gender Role Differences in O&M of the irrigation system

Site	Weir construction	Material gathering for weir construction	Weir repair	De-silting of impound	Furrow maintenance	Introducing water to the field
Malashi	▲	■	N/A	■	■	■
Nselka	▲	●	▲	■	■	■
Chaiteka	▲	●	N/A	▲	▲	▲
Chilala	▲	●	N/A	▲	■	■
Kasonde	▲	●	N/A	■	▲	▲
Miliwa	■	■	■	■	■	■
Kakose	▲	▲	■	N/A	■	▲
Chibolya	■	■	▲	N/A	▲	■

▲ Mainly by male ● Mainly by female ■ Equal

Source: JICA T-COBSI Project Team (Feb 2013)

Regarding the repair of the weir, 4 sites do not repair the concrete weir. According to the farmers, this is because extension workers or TSB officers are expected to repair when need arises. However, in

Chibolya site, the right bank of concrete weir was washed down, thus, members constructed temporally weir to reserve water and they are maintaining this temporary weir.

There is less significant gender difference in de-silting of impound, furrow maintenance, and introducing water to the field. It can be identified that these are daily maintenance works related to furrow, which is located close to individual plot. Thus, these works are performed by both males and females.

Table 1.5.2 Gender Role Differences in Cultivation and Harvest

Site	Field Preparation	Seeding	Applying fertilizer	Weeding	Vegetable (irrigated)	Beans (irrigated)	Rain-fed Maize	Rice
Malashi	▲	●	●	■	●	●	■	N/A
Nselka	▲	■	■	■	●	●	■	●
Chaiteka	■	■	■	■	▲	●	■	N/A
Chilala	▲	■	■	■	■	■	■	●
Kasonde	■	●	■	■	●	●	■	N/A
Miliwa	■	●	▲	●	■	●	▲	N/A
Kakose	■	■	■	●	●	N/A	■	N/A
Chibolya	■	■	■	■	●	●	■	N/A

Source: JICA T-COBSI Project Team (Feb 2013)

When it comes to cultivation and harvest, less gender role differences are observed. According to farmers, females tend to belong to works requiring less power, however the work with delicacy of touch to pick vegetables and weeding. On the other hand, male famers take heavy labor, such as field preparation.

Table 1.5.3 Gender Role Differences in Marketing

Site	Carrying products to the market	Selling products in the market	Selling to middle man at the farm gate	Selling Rainfed maize	Keeping money	Decision making in spending money
Malashi	●	●	●	▲	●	■
Nselka	▲	▲	●	▲	●	▲
Chaiteka	▲	▲	▲	▲	●	▲
Chilala	▲	▲	▲	■	●	▲
Kasonde	▲	▲	●	■	●	▲
Miliwa	■	●	▲	▲	●	■
Kakose	▲	N/A	▲	■	●	▲
Chibolya	▲	●	●	■	●	▲

Source: JICA T-COBSI Project Team (Feb 2013)

As regards carrying product to the market, 6 sites answered that male farmers transport because it involves long distances to the market. Usually, they sell the product to wholesaler and come back to village. In case they need to stay and sell it to customers, female farmers take part in selling because women are good at communication, according to male famer answered. Rain fed maize is sold to the government; more male seems to take charge of this role.

There are very significant role differences between Keeping money and Decision making in spending same money. Even female take responsibility to keep money in all the sites, male farmers make decision on what and how to spend it. This custom induces female members to complain at every site.

2) Review on Gender Issue

In the survey, the group interview was implemented especially on gender issues. Only female member was gathered and interviewed by the female expert. As a result, it was understood that women take in role of keeping money both in irrigation group committee and in households. There are several opinions why women tend to keep money in their society. According to female members, men use money without planning, such as using all money on beer, using money on girlfriends, using money to get married to

second wife. Male members did not deny these answers; thus it is considered more or less true. Beside these serious problems, female member reported the existence of domestic violence from husband. Despite of the fact that male dominant society, women have their own strategies to protect themselves as below.

Women Ownership Land Called "Impanga Yakwanamayo"

In almost all the sites, 30% to 40% of interviewed female members inherited their own land from their parents when they got married. In this women-owned land, women can decide what they can cultivate without asking for their husbands' permission. And the landownership belongs to women even if their husband died. The area is ranges from a few limas to 5 ha for each woman.

According to female members, they use the profit from the product of their land for children's education and clothes, dishes, livestock, and rarely gift for husband and herself. Even those women did not inherit land can borrow the land from other women who have. It is found that many women are dealing with their vulnerability with owning their land and getting profit from that.

Women's group

Among 4 sites out of 8 permanent schemes, female famers organize women`s group. Their activities are ranging from welfare activity, such as caring for aged people, widows and orphans, to cultural activity, such as leaning sewing, and making soap. Women group in Chaiteka site of Luwing district, own cultivated land upland. The member cultivates the land and use the income to expand their activities. Women group in Chilala site in Mprokoso district: they develop new cultivated land and use the profit to expand the cultivation land. These cultivated lands are not irrigated land but upland. T-COBSI project can cooperate for women's empowerment with using irrigated land in future.

1.6 MARKETING

In the marketing survey, following issues have been addressed: 1) marketing activities by the farmers in existing irrigation schemes; 2) purchasing activities of vegetables by venders in local markets; and 3) gap analysis on the cognizance of market trend between venders and farmers.

1) Marketing Activities by the Farmers in Existing Irrigation Schemes

Among the existing irrigation schemes surveyed, Kakose permanent-weir irrigation scheme of Mansa district in Luapula province, marketing activities were quite functional. In this scheme, the permanent weir was constructed in the pilot project of the COBSI Study and today bananas are cultivated on 3 ha of farmland under irrigation. On behalf of the scheme, the chairperson of the scheme carries the produce (bananas) on small truck to Mansa market about 60 km away from the scheme. Nonetheless, this seems to be a special case. In reality, group-selling is rarely observed in other irrigation schemes in the target area; marketing is usually administered individually.

A number of different units and measures are employed in the pricing of most agricultural commodities i.e.: box, bag, bucket are used instead of weight in kilograms. For packaging, unified size of wooden-box is usually used for tomato but, for other crops, sack is commonly used, having a standard size to be 50kg or 90kg when fulfilled with grains of maze. As a result, it can be said that pricing is done in accordance with a roughly standardized unit for each crop.

Subsequently, means of transportation is addressed. With the case of Kakose being exceptional where small truck is employed to carry banana, most farmers carry their produces by themselves by putting on their head or by bicycle. Alternatively, venders or middleperson also visit farmers' place during high-season when it is difficult to secure the produce and there is competition among the venders. In the case of marketing, the closer the location of irrigation scheme is to the market, the more the advantage in

marketing—this is also a considerable factor for the selection of the area to be developed.

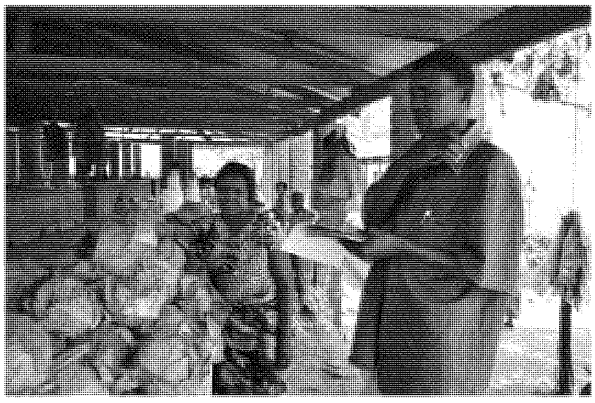
Acquiring market information, farmers rely on various source of information such as neighbors, extension officers, and radio. The most common way is, however, to get price information from venders when farmers sell their produces in the market. According to a series of interviews made to farmer groups in the target area, there was no farmer group that conducts a decent market survey by themselves. Instead, farmers usually look for the marketing channel in the harvesting season when it is ready to sell.

There are also some areas where farmers have difficulties in obtaining market information through mobile phone as they are out of coverage area. After all, it is not so easy for farmers to obtain market price information by themselves and therefore it is likely that farming plan is not usually formulated based on the market information.

2) Purchasing Activities by Venders

At a couple of major markets in the target area, interview survey was conducted on the venders on their purchasing activities from farmers. Essentially, this survey was to understand what kinds of crops are sold at high prices, what seasons and what type of factors are considered as to see the quality of crops. The types of crops addressed in this survey were: tomato, onion, and cabbage which were complemented with some other crops that provide relatively bigger profit to the venders.

In this survey, a pre-determined questionnaire was employed to capture the marketing trend of these crops by asking 3 to 4 venders in each market. In the project, farmers will be trained to carry out marketing survey by themselves so as to make more reasonable farming strategy based on the market demand. Accordingly, the questionnaire was kept as simple as possible so that farmers can use in the future. The survey was conducted in six markets. Table 1.6.1 summarizes the marketing trend of tomato derived from the survey as an example. There is a difference in the seasons of high-demand or low-demand amongst the markets surveyed, suggesting that, to ship the harvests in the high season, farmers adjust the planting season in accordance with the market trend of the particular market where farmers target to sell. To this end, marketing survey needs to be carried out before the planting season.



A counterpart officer makes interview to a vender (Luwingu district, Northern province)

Table 1.6.1 Marketing Trend of Tomato in Six Major Markets in the Target Area

Market	Location (District/Province)	Season in High Demand	Season in Low Demand
Chambeshi Market	Kasama, Northern	Jun-Sep, Jan-Feb	Oct-Nov
Luwingu Main Market	Luwingu, Northern	Nov-Apr	Aug-Oct
Musakanya Market	Mpika, Northern	Jan-Mar, May-Jun	Aug-Nov
Mukando Turn-off Market	Serenje, Central	Jun-Aug	Sep-Dec
Down UB Market	Mansa, Luapula	Jan-Feb	Aug-Nov
Chimfembe Market	Kawambwa, Luapula	Nov-Apr	Apr-Sep

Source: T-COBSI Project Team (2013)

3) Gap Analysis on the Cognizance of Market Trend between Venders and Farmers.

Based on the interview made to the venders as well as some supplemental survey made on farmer groups, an analysis was made on the gap between the cognitions of venders and farmers about the market trend, particularly their cognitions on the high-demand season. As shown in Table 1.6.2, there is relatively a

bigger gap between the recognition of the two parties about the high-demand season of tomato and rape, while there is not much gap about onion and cabbage.

Based on the past experience in selling, farmer groups have some understanding about a general trend of market prices; however, it is not at the level of each crop. In addition to this general gap between venders (buyers) and farmers, there are variations of market trend by the location of market, caused probably by difference in climate, total supply in the area, change in taste of consumer, etc.

To adapt to such variations in market trend, it is recommended for farmer groups to obtain the latest information of market trend through periodical market survey and/or accessing to market information systems by mobile phones, rather than relying only on their past experience. To this end, market survey will be one of the programs in the training program of the project.

Table 1.6.2 High-Demand Seasons Recognized by Venders and Farmers

Market	Crop	High-Demand Season Recognized by Venders	High-Demand Season Recognized by Farmers	Degree of Gap
Chanbeshi Market Kasama, Northern	Tomato	Jan - Feb, Jun - Sep	Apr - Jul	Big
	Onion	Jan - Apr	Jan - Aug	Medium
	Cabbage	Oct - Nov	Sep - Dec	Small
	Rape	Apr - Jun	Apr - Aug, Oct - Dec	Big
Musakanya Market Mpika, Muchinga	Tomato	Jan - Mar, May-Jun	Feb - Jul	Medium
	Onion	Dec - Apr	Dec - Feb	Small
	Cabbage	Nov - Mar	Dec - Apr	Small
	Rape	Oct - Jan	All-year-long	Big
Down UB Market Mansa, Luapula	Tomato	Jan、Feb	Sep - Jan	Big
	Onion	Jan、Feb	Dec - Feb	Small
	Cabbage	Nov - Jan	Oct - Jan	Small
	Rape	Sep - Nov	All-year-long	Big

Source: T-COBSI Project Team (2013)

1.7 IMPACT OF COBSI PERMANENT IRRIGATION SCHEMES

There are beneficiary's impressions after the implementation of the COBSI pilot project. Most sites appear to have improved in their living as a result of income generation from irrigated land. However Malashi site of Mpika district and Kasonde site of Mporokoso could not answer on improvement because the irrigation scheme is non-functional. In order to deal with the problem they are facing, cooperation is required from Mporokoso district office in the construction of road culverts and also doing the coordination on the upper stream site of Malashi in Mpika district.

Table 1.7.1 Impact observed after the COBSI Pilot Project

Site	Improvement after the COBSI Pilot Project
Nselka	Poverty was reduced and income is increased/ Wife and husband used to be working separately in different field but now they are working together in irrigated area/ This change makes them to share time more than before; then, misunderstandings were reduced and relation became better now/ The irrigated plot was provided equally to wife and husband, making it possible for women to buy what they like with their own decision/ Income is doubled because wife and husband can cultivate individually.
Chaiteka	Improvement of food security/ Being able to pay for school fees / Improvement of livelihood / Being able to buy soap/ dressing better now/ Being able to buy spars for bicycle.
Chilala	Being able to pay for school/ buy bicycle/ buy clothes and beddings.
Miliwa	Being able to build iron roofed houses/ Children are able to go to school/ Improvement of nutrition.
Kakose	Being able to have three meals per day/ Became healthy/ Improvement of nutrition
Chibolya	Improvement of housing (iron roof)/ Purchase of solar powered systems/ purchase of bicycled for easy transportation to BOMA, the district capital / Improvement of nutrition at household level

Source: JICA T-COBSI Project Team (Feb 2013)