JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
DEPARTMENT OF IRRIGATION (DOI), MINISTRY OF AGRICULTURE (MOA), REPUBLIC OF MALAWI

THE STUDY ON THE CAPACITY BUILDING AND DEVELOPMENT FOR SMALLHOLDER IRRIGATION SCHEMES IN THE REPUBLIC OF MALAWI

TECHNICAL MANUAL

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Foreword

This Technical Manual is a part of Smallholder Irrigation Development Package produced under the Study on the Capacity Building and Development for Smallholder Irrigation Schemes in the Republic of Malawi. The Study was carried out from January 2003 to February 2004 in partnership with all those concerned officers of the Ministry of Agriculture. The Study produced following dissemination materials for smallholder irrigation development, which altogether consist of the Package.

1) Comprehensive Guideline
2) Technical Manuals
3) Posters (5 sheets of A-2 size)
4) Leaflets (English and Chichewa versions)
5) Picture Stories

Ideas incorporated in this Manual are fully based on the experiences of the Study, which included the implementation of verification projects to examine the best technologies appropriate in the context of Malawi. The Study, throughout the verification projects, conducted various trials on diversion weirs depending on each field condition, canal alignment with a very simple tool that is line level, on-farm irrigation methods, etc. and also low-input agriculture components promoted with the smallholder irrigation.

This Manual is structured with two steps that are "Irrigation Component" – presenting various irrigation facilities that can be constructed in the smallholders' locality without depending much on outside physical assistance and "Agriculture Component" – centering on low input agriculture by means of promotion of compost manure, botanical pesticide, improved granary made out of locally available materials, etc. Although ideas is this manual should not be over generalized, they are expected to be tools of practical application to further extend similar smallholder irrigation development to wherever there is potential.

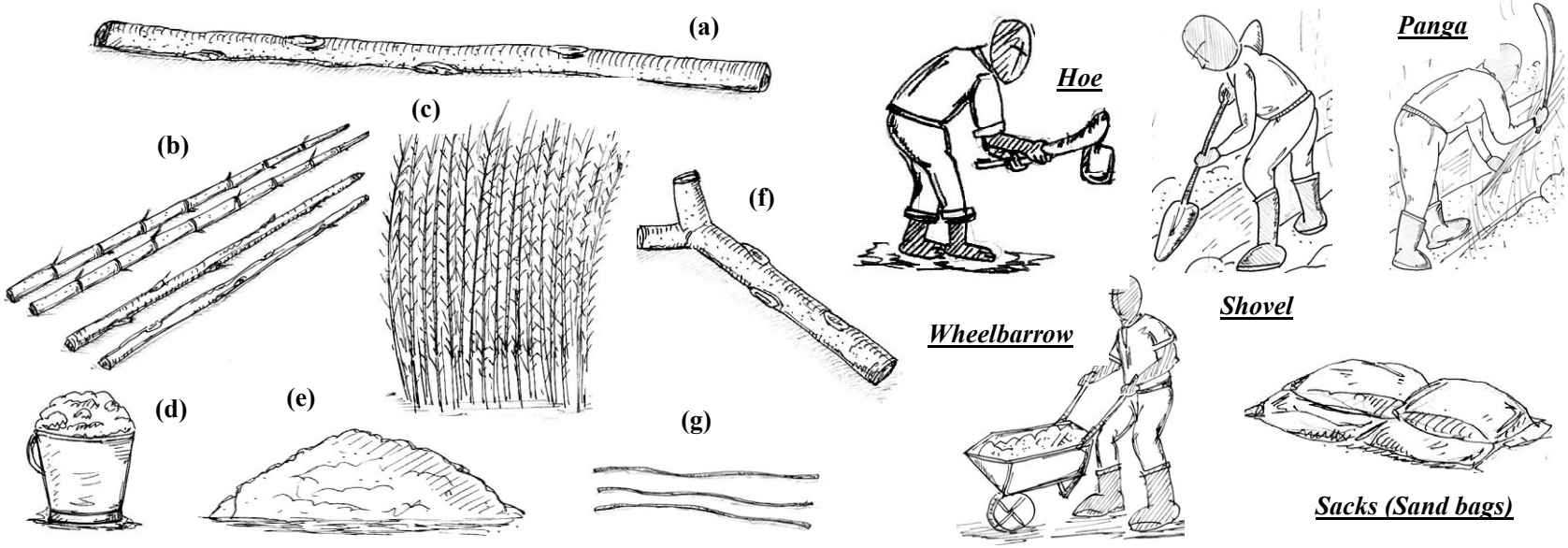
Readers of this Manual are to be the Government frontline extension officers or development practitioners for smallholder irrigation on the ground. We expect the readers to utilize this Manual in respect of each condition, but also to try out the disciplines asserted throughout the text in practice. Being still humble enough for over generalization, experiences in the verification projects are illustrated as much as possible corresponding to the general description of the ideas to indicate how the ideas are to be realized. However we also believe that the actual experience is the living source of the text to be conveyed from its origin to various contexts.

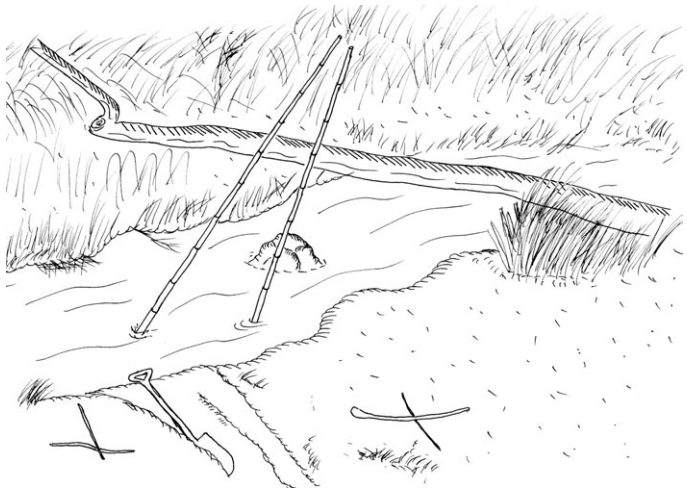
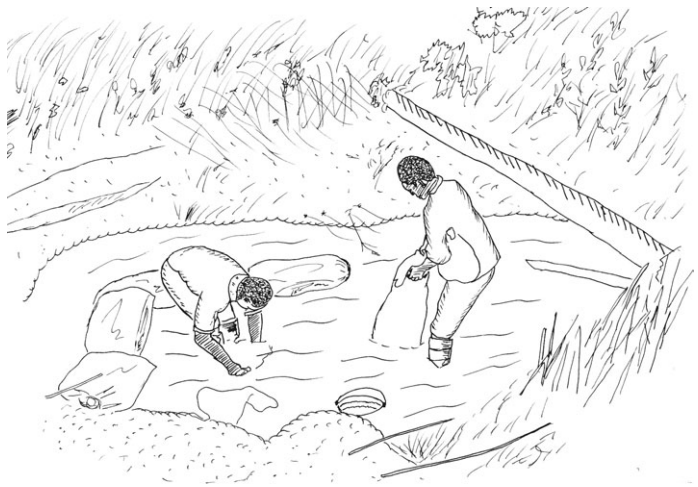
CONTENTS

IRRIGATION FACILITIES;

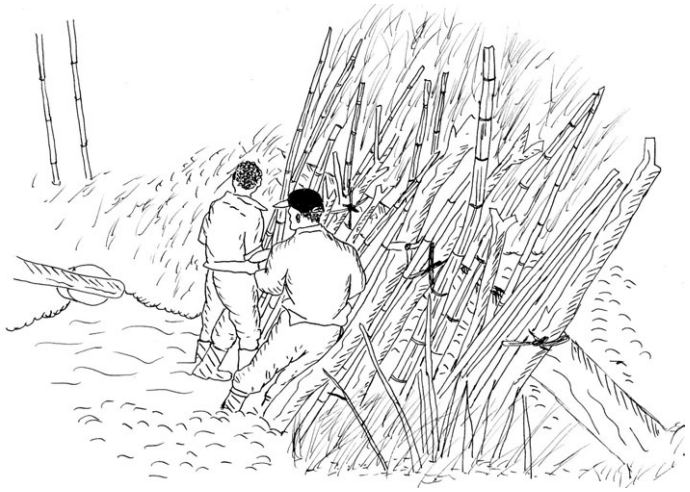
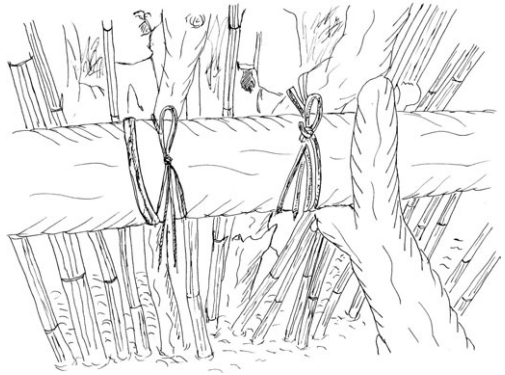
AGRICULTURE COMPONENTS;

1. Construction of Brush Dam: Inclined Wall Type (Type-A)

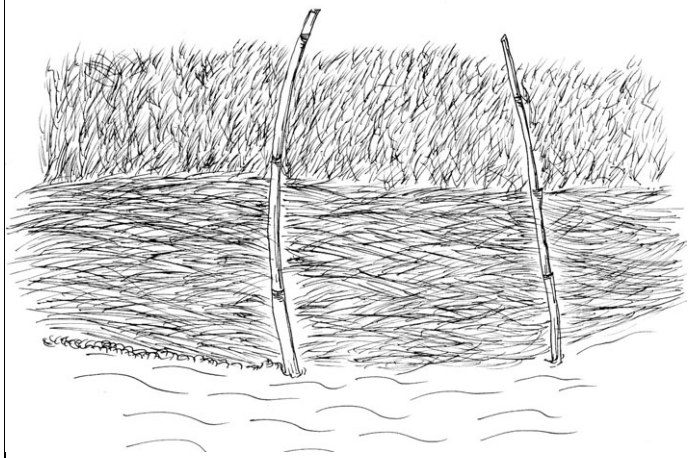
Step	*Materials to be collected*
0	***Collect all the following materials**;* *(a) A log: to be put horizontally on the stream bank across the diversion point (Quantity: 1 nos., Refer to Step-1)* *(b) Bamboo/Twigs: to stand in front of the horizontal log (Quantity: 8 – 10 nos. per 1 meter width of the Dam, Refer to Step-4)* *(c) Grasses (Elephant grass) : to be put in front of vertical members (Quantity: depend on size of the Dam, Refer to Step-5)* *(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 size of the Dam, Refer to Step-3 & Step-7)* *(e) Ordinary soil: to patch on the clay soil patched on the grass (Quantity: depend on size of the Dam, Refer to Step-8)* *(f) Log: to support the Brush Dam (Quantity: depend on size of the Dam, Refer to the illustration)* *(g) Creeper: to fix the Bamboo/Twigs to the horizontal log (Refer to Step-4)* ***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		***Put A Log Horizontally;*** *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 a 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 site condition such as width of stream. In case of a cerrtain site in Lilongwe district, the log having 4.8m of length was put on the bank of stream having 3.7m of stream width.*
2		***Construction of Cofferdam;*** *To replace the foundation of stream, dewatering is carried out by a simple cofferdam.*	*In case of the site where the material of stream bed is composed of 0.8m sand thickness,, there is a need to replace the sand layer with imported clay soil. To make replacement work easy, the cofferdam is constructed using sandbags. If the sacks are not available at the site, the banking (soil filling) can be applied. Cofferdam should be constructed in halves in the stream. In case of the site, 10 nos. of sand bags are set.*

Step	*Process*	*Description*	*Remarks*
3		***<u>Replacement of Stream Foundation (Bed);</u>*** *Replace the sand bed material of the stream by clay soil, when construction of cofferdam is complete.*	*To prevent water leakage by boiling due to sand bed material of stream, the foundation is replaced by imported clay soil. While dewatering and excavation of sand are done, the clay soil is thrown into stream bed and is compacted physically by feet. The thickness of clay will depend on the depth of sand which has been excavated (up to the thickness of sand sedimentation). In a certain site, 2 cum of clay soil were thrown to fill the depth of 0.8 m of sand which was excavated.*
		*<u>Refer to the Illustration</u>* *Putting of clay soils in the excavated area and importation of clay soils.*	*Clay which is filled in the stream bed to replace the sand foundation is compacted physically by feet.* *Women also take part in the construction of the weir. There main activity being carrying the clay soils.* 

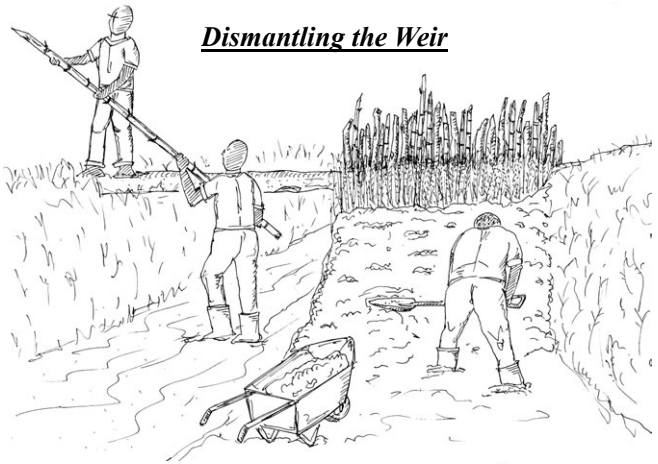
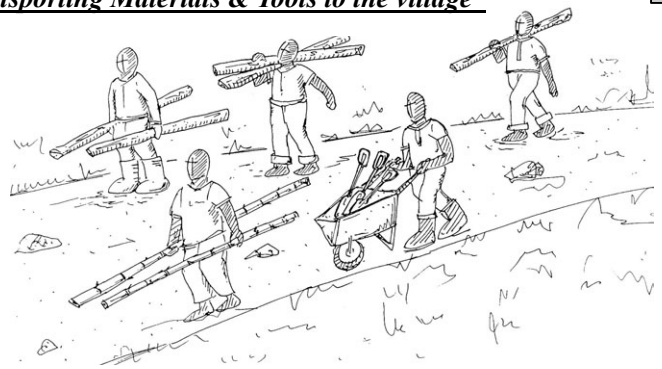
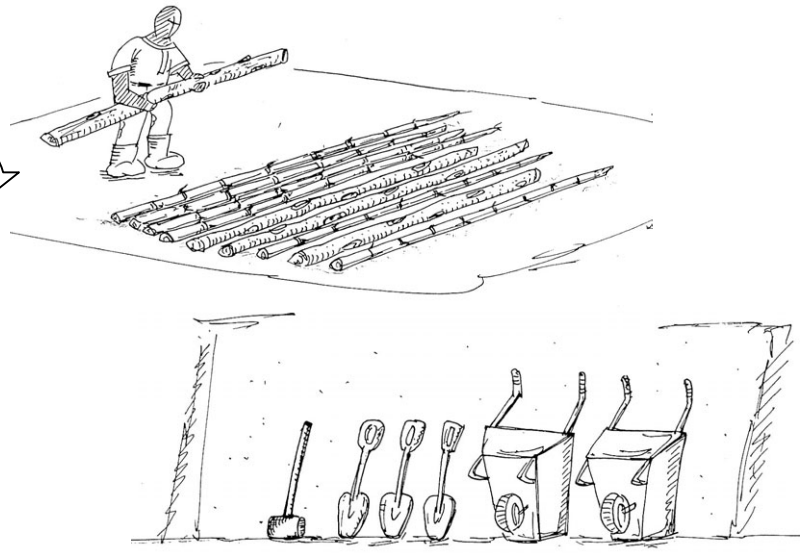
Step	*Process*	*Description*	*Remarks*
4		***<u>Stand the Vertical Members;</u>*** *The vertical members composed of bamboo/twigs are put in front of the horizontal supporting log as seen in the illustration.*	*To put grasses and soil easily, the vertical members such as bamboo/twigs should be put as close as possible together. These vertical members are placed into the foundation which has been replaced by clay soil and again connected to horizontal support log at the top, using materials such as runner (see the illustration of lower right).*
		*<u>Refer to the Illustration</u>*	*Placement of vertical members and tying of vertical members to the horizontal log by using creepers.* 

Step	*Process*	*Description*	*Remarks*
5		***<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.*
		*<u>Refer to the Illustration</u>*	*Another bamboo is horizontally placed in front of the grass and fastened to the vertical members behind to keep the grass in position, as shown in the illustration in the left hand.*

Step	*Process*	*Description*	*Remarks*
6		***<u>Pile the Grasses</u>***; *Grasses are piled horizontally on vertical standing grasses. See the illustration to the left.*	*To prevent swelling out of grasses, the grasses are bound by a vertical member (bamboo) once again.*
		*<u>Refer to the Illustration</u>* *Horizontal placement of grasses in front of standing grasses.*	*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 almost water tight.*

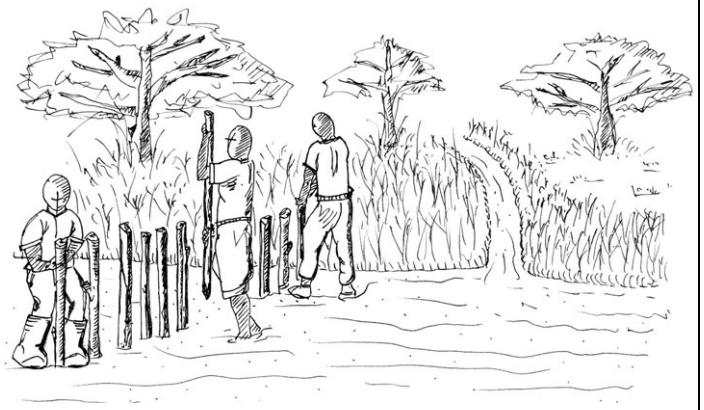
Step	*Process*	*Description*	*Remarks*
7		***Patch the Clay Soil;*** *The clay soil is patched on the grasses See the illustration in the left hand.*	*To prevent water leakage, the clay soil is patched tightly on the grasses. The clay soil is put not only on grasses as a part of dam but also on the stream banks in contact with the weir as shown in the illustration.*
8		***Add the Soil on Top of Clay Soil;*** *The clay soil is covered by soil collected from around the dam.*	*Furthermore, to significantly prevent water leakage, the layer of clay soil constructed on step No.7 is covered by soil existing around the dam.*

Step	*Process*	*Description*	*Remarks*
6 - 8		***Compaction by Feet;*** *The grasses and soils are compacted physically (manually) by feet.*	*On step No.6 to 8, it is important to tread the materials as hard as possible in order to minimize the gap existing in grasses and soil.*
9		***Completion of Construction;*** *The weir is then completed. See the illustration in the left hand.* ***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/ordinary soil. This process will restore the weir its former good shape, as the hole will be a source of weakness where the structure can fail.*	*The dimensions of the weir shown in the last page are as follows;* *-Length of the weir: 3.7m* *-Height of the weir: 1.0m* *-Depth of tapped water: 0.75m* 

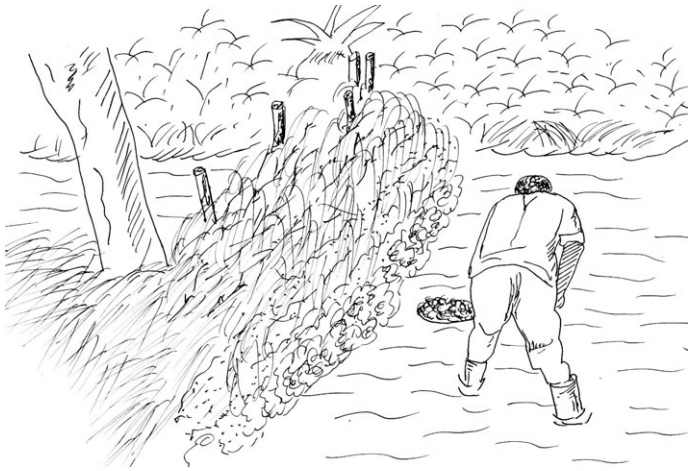
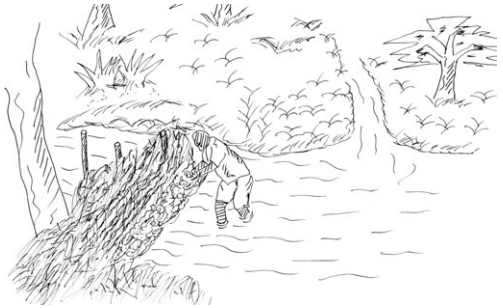
Step	Process	Description
10	***Dismantling the Weir***  ***Washing the Tools***  ***Transporting Materials & Tools to the village*** 	***Note; Dismantling the Weir and Set Aside the Main Materials*** *These types of weirs are constructed as temporary facility for the intake of stream water for irrigation 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, and this situation will cause inundation to the farm land. Then, the main materials and tools such logs, bamboos and twigs as construction materials, while wheelbarrows and shovels as tools, are 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*** 

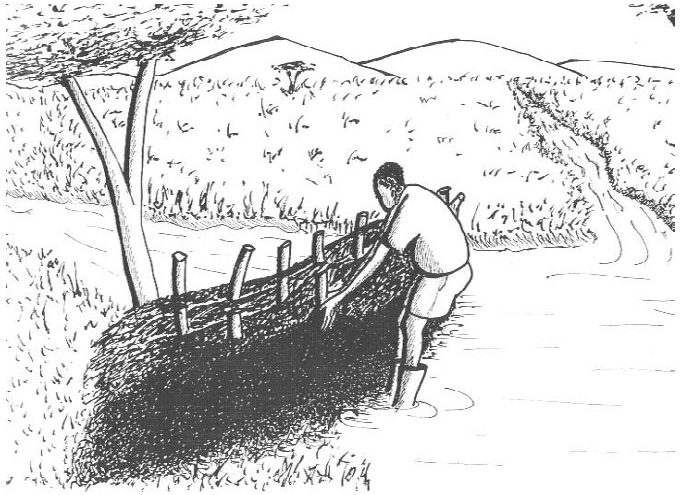
The Exterior of Brush Dam (Type-A)

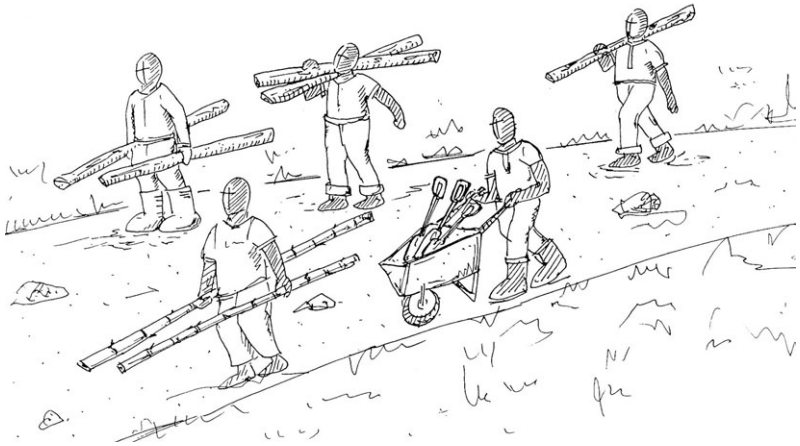
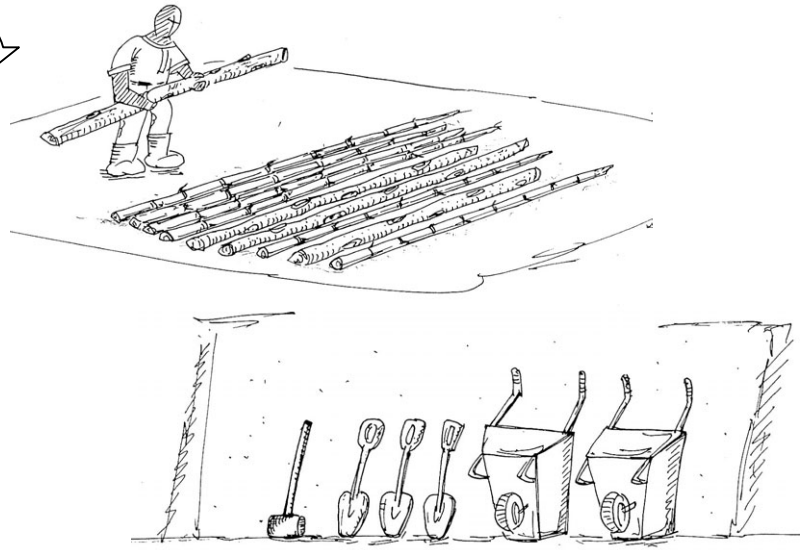
2. Construction of Brush Dam: Vertical Wall Type (Type-B)

Step	*Process*	*Description*	*Remarks*
1		***Position the Wooden Poles;*** *Position the wooden poles at the diversion point across the stream.*	*In case of a certain site in Kasungu district, width of the stream at diversion point is 5.5 m. About 20 wooden poles were piled with 0.2 - 0.3m of interval, thus, in short, there are 3 to 5 numbers. of wooden poles per one meter. The poles were driven into the ground at a depth of 0.3m, below the foundation. Length of the pole depends on site condition, more especially in relation to the design tapping water level. In case of this site, the poles having 1m of length was used for 0.4m of tapping water depth.*
		*Refer to the Illustration* *Good straight poles with a sizable diameter should be the ones to be used during this step.*	*The hammering of the poles into 0.3 m below the bed level was done in order to overpass the sand foundation, which would be prone to scouring effect if placed above 0.3m.*

Step	*Process*	*Description*	*Remarks*
2		***<u>Weave the Grass Fence to Tap the Stream Flow;</u>*** *To tap the stream flow, grasses (elephant grass etc.) are woven horizontally into the poles. See the illustration in the left hand.*	*The grasses are bundled and woven horizontally between the wooden poles. The bundled woven grasses are treaded layer by layer as they are put criss-crossing on upright logs. This compaction is done in order to achieve a water tight situation.*
		*<u>Refer to the Illustrations</u>* *The process that is involved in weaving the grass between the poles.* 	*A good chunk of grass is taken then is twisted and finally it is woven between poles. 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* 

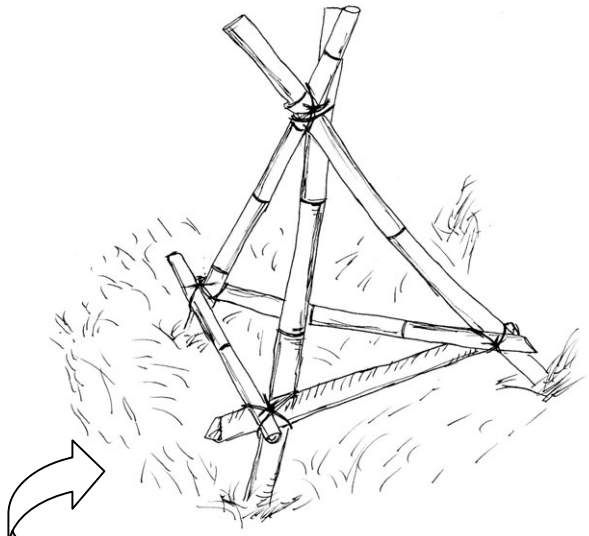
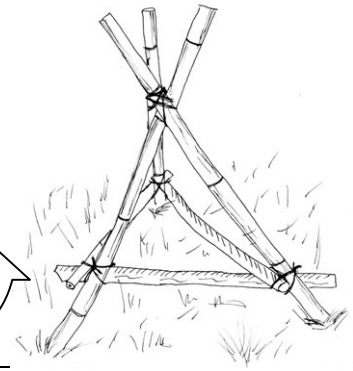
Step	*Process*	*Description*	*Remarks*
3		***<u>Put the clay soil / soil on the Grass Fence;</u>*** *Put the clay soil on the grass fence.* *Using clay soil and ordinary soil has been proved to perform much better than using sandbags, when the objective is to prevent boiling/piping behind / bottom / downstream of the weir.*	*To prevent water leakage from the grass fence and boiling due to sand bed material of the stream, the clay soils are put on the grass fence and the bottom of stream up to foundation level.* 
		*<u>Refer to the Illustration</u>* *The clay soil is collected around the diversion site.*	*It is not 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, the soil (stream bed material) is thrown to the grass fence.*

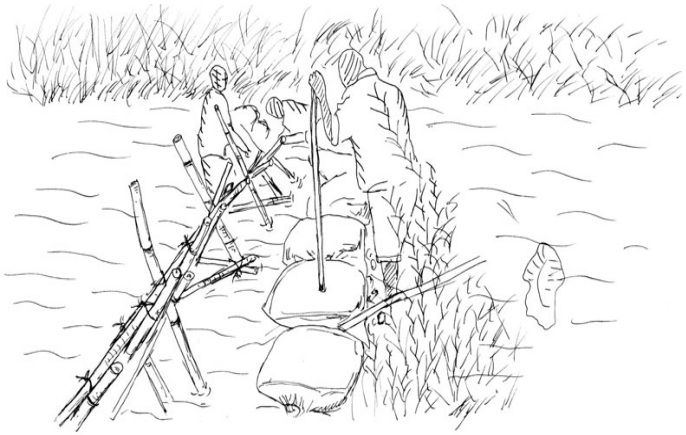
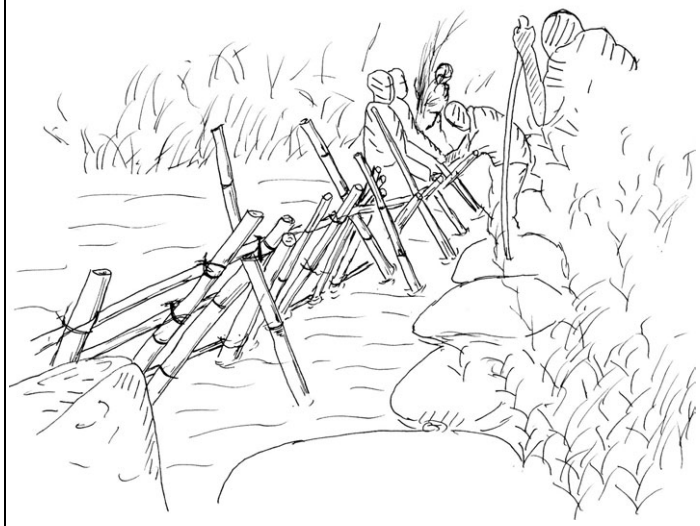
Step	*Process*	*Description*	*Remarks*
4		***Completion of Construction;*** *The weir is completed after following all the steps.*	*The dimensions of the weir shown in the last page are as follows;* *-Length of the weir: 5.5m* *-Height of the weir: 0.7m* *-Depth of tapped water: 0.45m*
		Note; Maintaining the Weir *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 stopped by sealing with clay/ordinary soil. This process will restore the weir its former good shape.*	

Step	Process	Description
5	***Dismantling the Weir***	***Note; Dismantling the Weir and Set Aside the Main Materials***
	Washing the Tools	*This type of weir is constructed as a 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, and this situation will cause inundation to the farm land. Then, the main materials and tools such logs, bamboos and twigs as construction materials, while wheelbarrows and shovels as tools, are set aside at a suitable place in the village. If properly stored, these materials will be reused for few years to come.*
		
	Transporting Materials & Tools to the village	***Setting aside the Materials & Tools***
		

The Exterior of Brush Dam (Type-B)

3. Construction of Brush Dam Supported by Trigonal Prop (Type-C)

Step	*Process*	*Description*	*Remarks*
1		***<u>Assemble the Trigonal Prop (Standing Structure);</u>*** *To support the fence made of grasses/clay soil, the trigonal prop (standing structures) are assembled as shown in the illustration.*	*The trigonal prop is made of log/bamboo. The size of this structure is adjusted depending on site condition in reference to the design tapping water level. In case of the illustration, each member was cut with a length of 1.3m for 0.5m of tapping water depth design. The diameter of logs/bamboos for the trigonal prop is around 7cm - 10cm each. The front of this structure, namely the upstream side, has an inclination to act as stand for the fence made of grasses and to put clay soil on the grass fence, and lastly, to reduce 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 round 70 - 80 degrees. To tie the members to each other, local materials such as runners/grass/sisal are used.*

Step	*Process*	*Description*	*Remarks*
2		***Set up the Trigonal Props;*** *The trigonal props are set at the diversion point.*	*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 Lilongwe district, the width of stream at diversion point to be set up by this trigonal prop weir is 8m (the width of stream itself is 20m actually) and four (4) trigonal props were set up giving an interval of 1.5m apart.*
3		***Fix the Horizontal Members to the Trigonal Props;*** *To place the grasses and put the clay soil on grasses in front of the trigonal props, the horizontal members are fixed to the trigonal props to keep them in place and in line to each other.*	*Horizontal members are to be fixed in front of the trigonal props, bamboos if available can be used. The diameter of fixed horizontal members is around 3cm-4cm each. As a result, all of the trigonal props are connected by the horizontal members and will withstand the water pressure as one structure. In case of the site, three (3) lines i.e. upper, middle and lower lines were fixed on the trigonal prop.*