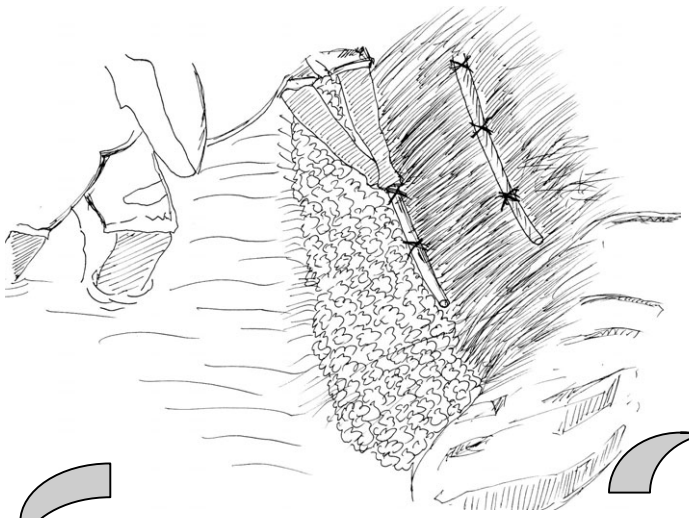
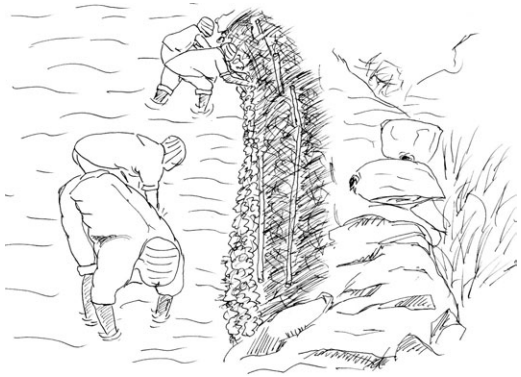
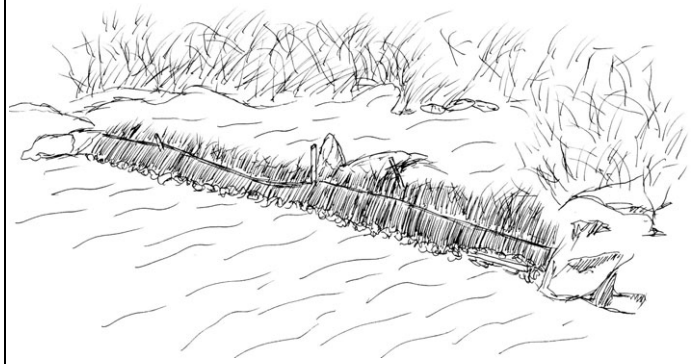
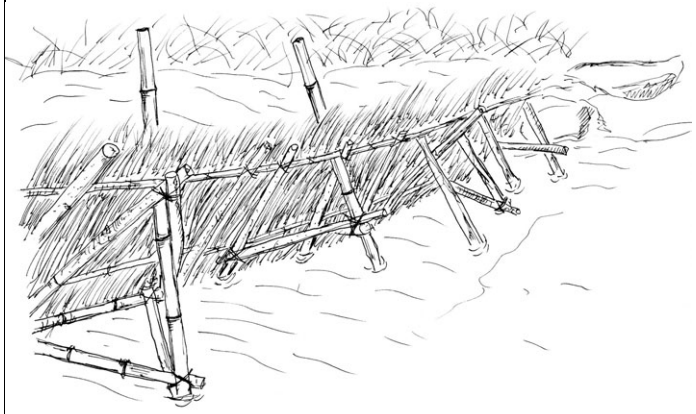
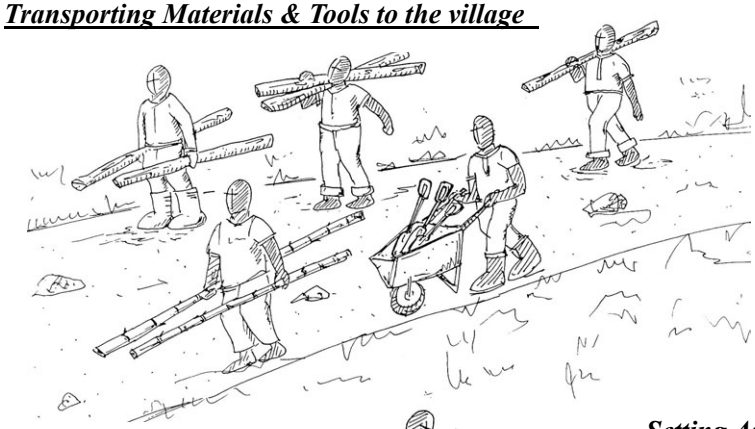
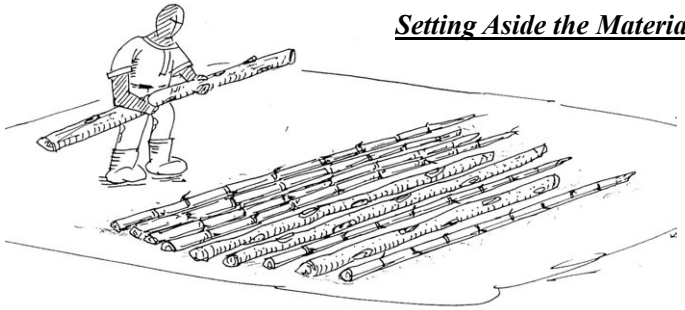
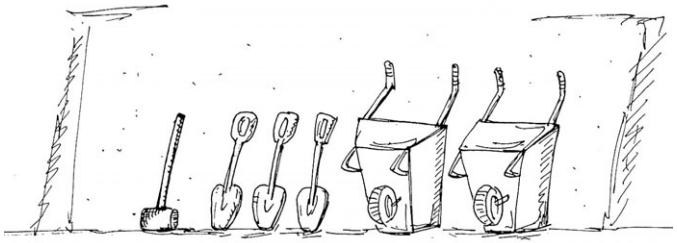
Step	*Process*	*Description*	*Remarks*
4		***<u>Place the Grasses;</u>*** *To tap the stream flow, the grasses are placed vertical in front of the trigonal props touching the bed level of the stream.*	*To reduce the water leakage, it is better to put the grasses very closely. In particular, around the bottom portion of stream, a lot of grasses should be used.*
		*<u>Refer to the Illustration</u>*	*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*
5		***<u>Tie the Standing Grasses to the Horizontal Members;</u>*** *To prevent swelling out the standing grasses, these grasses are pressed against the trigonal prop by using the horizontal members again tied with runners (inner type threads).*	*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.*
		*<u>Refer to the Illustrations</u>* *The horizontal members' placement. The three horizontally parallel members are finally fastened sandwiching the grass.* 	*The number of layers of horizontal members is dependent on the height of the trigonal weir. In case of the site, three (3) layers of horizontal members were placed on a trigonal of 1.3 m of height.*

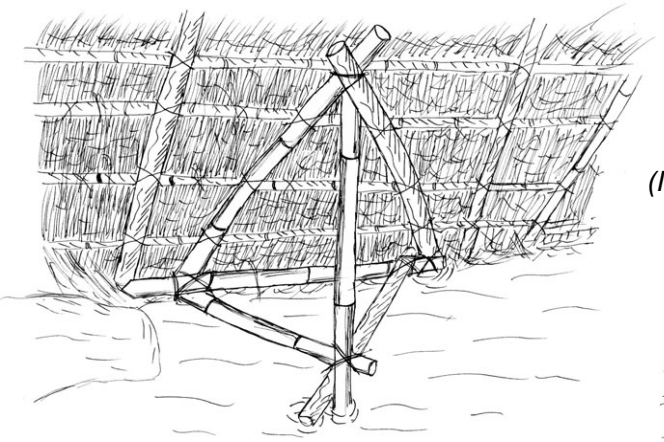
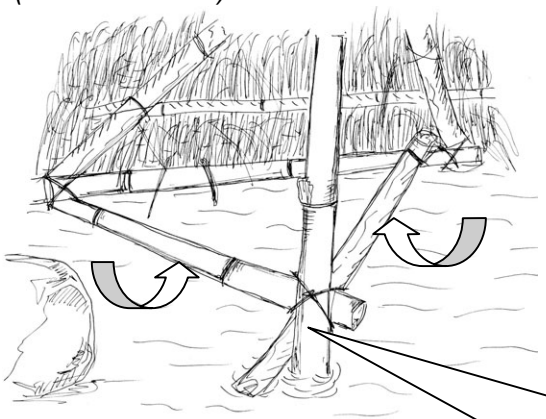
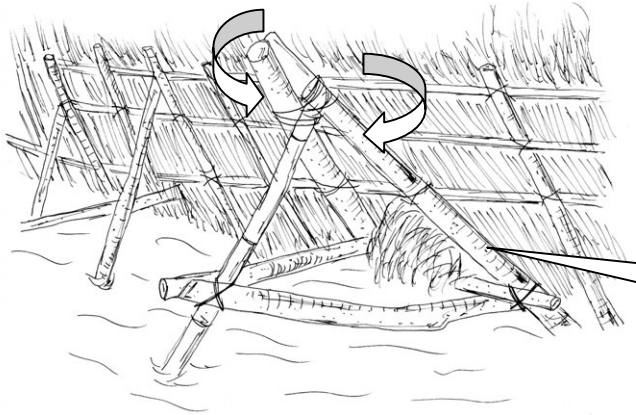
Step	Process	Description	Remarks
6		***<u>Put the Clay Soil on the Grass Fence;</u>*** *The clay soil is put on the grass fence starting from the foundation or streambed level.*	*To prevent water leakage, the clay soil is patched on the grass fence. The clay soil is put not only on the grasses as a part of dam but also the gap between the edge of the grass fence and the natural grand/exposed rock starting from the streambed level.*
		*<u>Refer to the Illustrations</u>* *Bottom placement of clay as an initial stage of clay patching has to start from the foundation level.* 	*Putting of clay soil should be started at the bottom. Much attention should be put at this stage because this area is very critical in reducing water leakage and thus where the water pressure is the greatest. A lot of clay soil should be placed at the bottom in order to make it water tight as much as possible to prevent boiling/piping and even overtopping.*

Step	*Process*	*Description*	*Remarks*
7		***<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.* 	*The dimensions of the weir are as follows;* *-Length of the weir: 8.0m* *-Height of the weir: 0.8m* *-Depth of tapped water: 0.55m* *With this trigonal supported weir, water depth stored could reach around 2m. However, the higher the water level is, the riskier it is. Therefore, it is not recommended to store water nearly about 2m or a little bit more.*
		*<u>Refer to the Illustration & Photo</u>* *<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.*

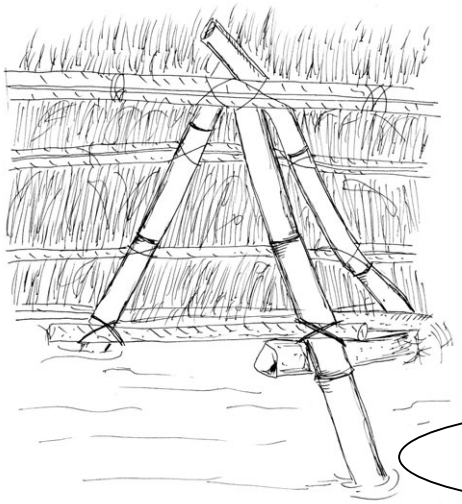
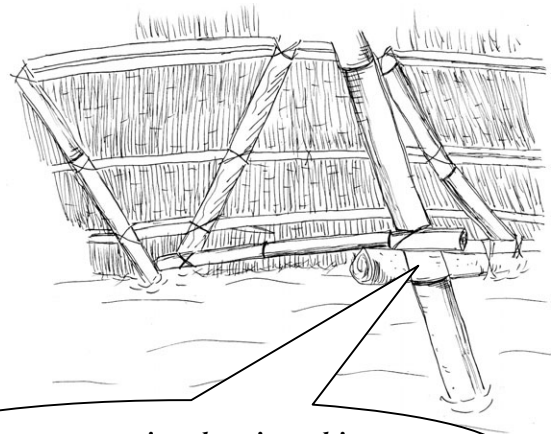
Step	Process	Description
8	***Dismantling the Weir***	***Note; Maintaining the Weir***
	Washing the Tools 	*During operation of the irrigated farming, the diversion weir should be maintained carefully. For instance, if a hole is found on the weir, it should be immediately stopped by sealing it with clay/ordinary soil. This process will restore the weir its original good shape.*
	Transporting Materials & Tools to the village 	***Note; Dismantling the Weir and Set Aside the Main Materials*** *This type of weir is constructed as temporary facility for the intake of stream water for irrigation farming in dry season. Therefore, the weir should be dismantled just before the start of the rainy season because such kind of structures are constructed across the river/stream and such as the diversion weir becomes an obstruction for safety flow of floods, and this situation will causer 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 supported by Trigonal Prop (Type-C)

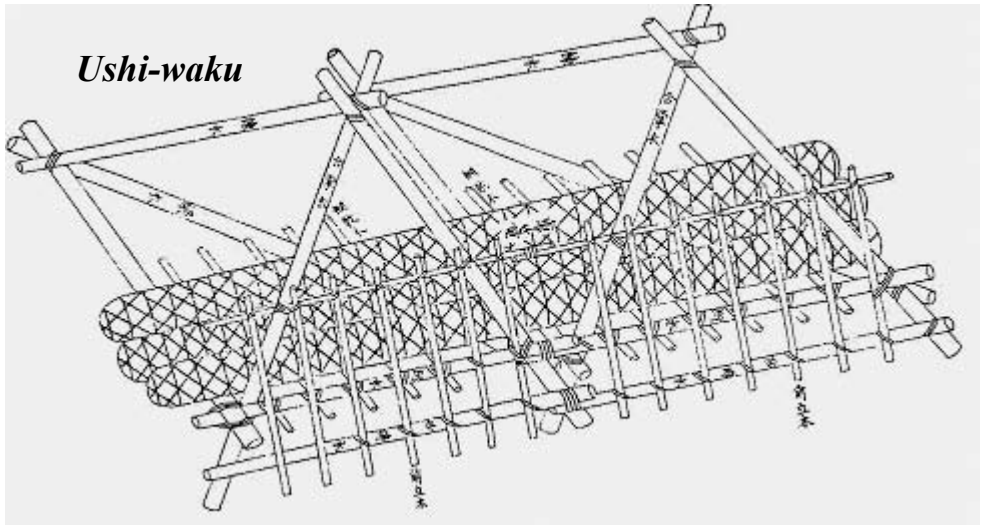
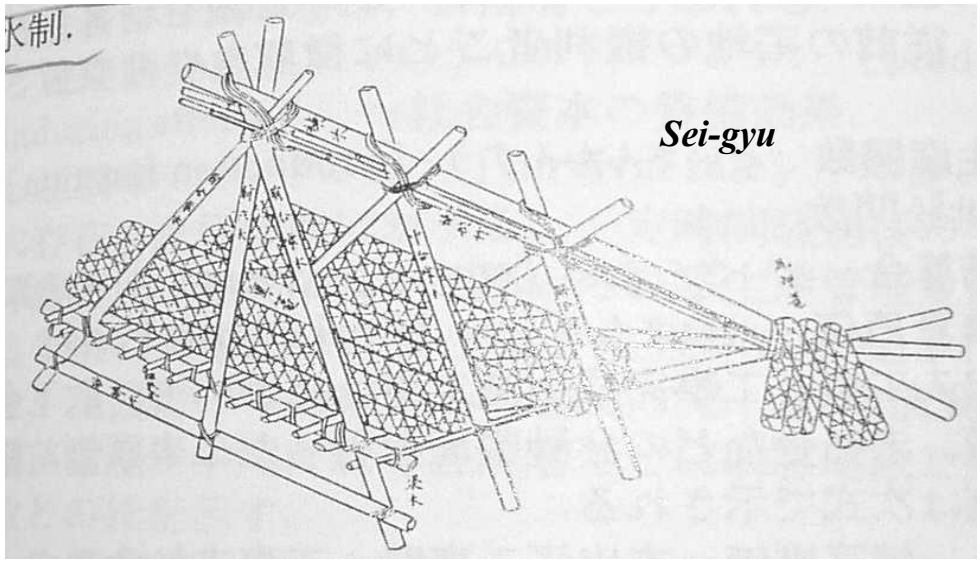
Assembling of the Trigonal Prop 1/2 (Good Samples of Making Knot)

Step	***Good Samples of Making Knot***	***Remarks***
	(Illustration No.1)  *(Illustration No.2)*  *(Illustration No.3)*  ***Two of horizontal members set at bottom are connected by strut between them.*** ***Two of vertical members set at front line are connected by the same strut between them.***	*No.1-No.3 of the illustrations show good samples of assembling the trigonal prop. The trigonal props can resist the water pressure because of proper / good (tying) knotting of the members composed in each structure. Two of horizontal members set at bottom are connected by strut between them. In the same way, two of vertical members set at front line are connected by the same strut between them. This type of assembly makes the trigonal prop more stable and more resistant against the water pressure.*

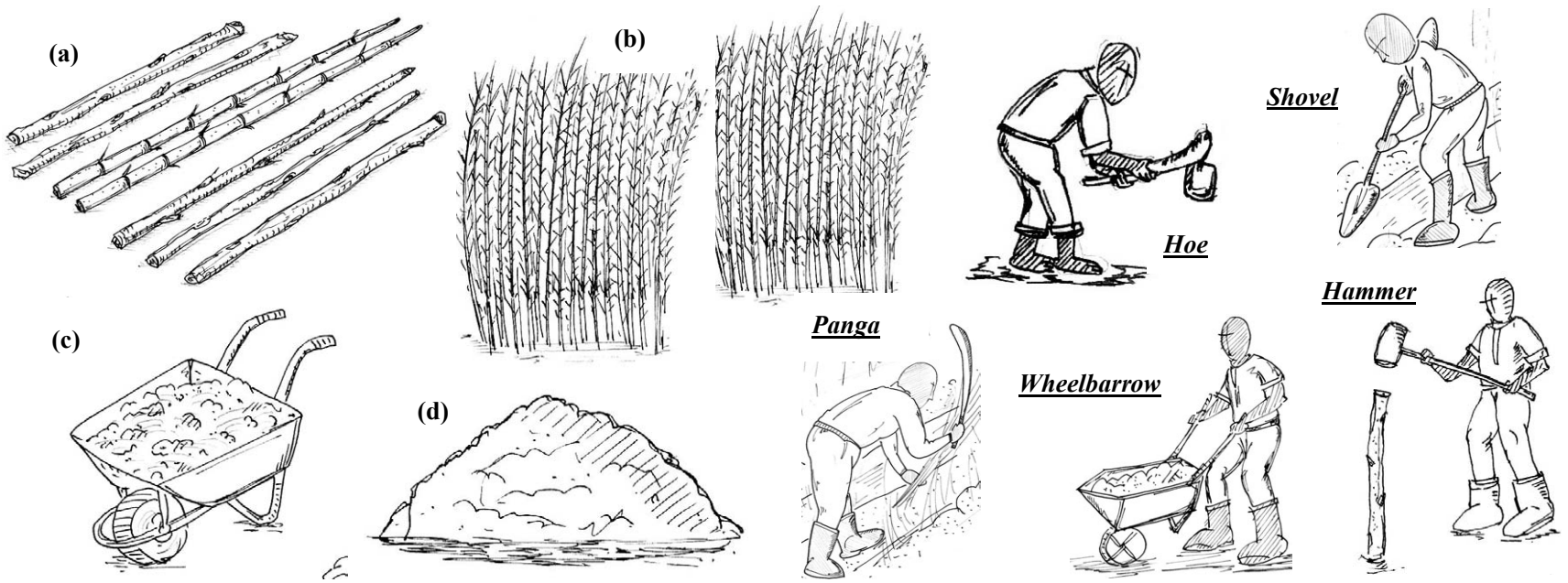
Assembling of the Trigonal Prop 2/2 (Bad Samples of Making Knot)

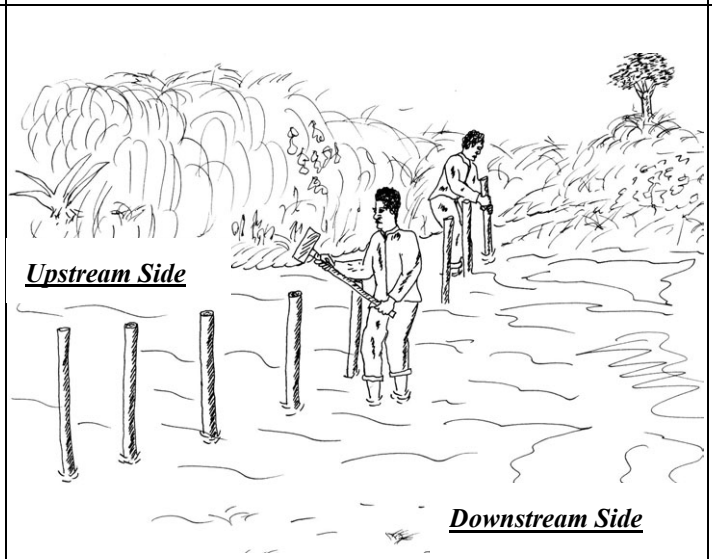
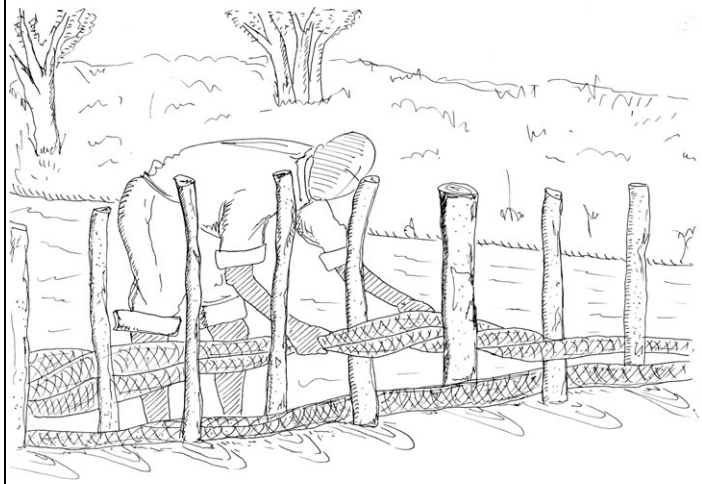
Step	***Bad Samples of Making Knot***	***Remarks***
	(Illustration No.4)  *(Illustration No.5)*  ***A strut supporting the trigonal is put out of the axis of the supporting line.*** *(Photo No.1)*  *(Photo No.2)* 	*On the other hand, the Illustration No.4 & No.5 show bad assembling of the trigonal structure. This type of structure is easily deformed by water pressure and needs other support members. A strut supporting the trigonal prop and the grass fence are tied at outside of the other two horizontal members so that a strut is put out of the axis of supporting line.*

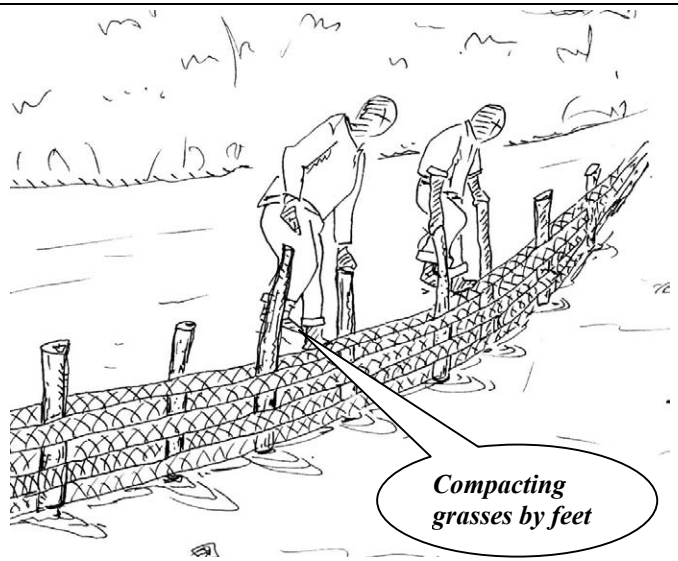
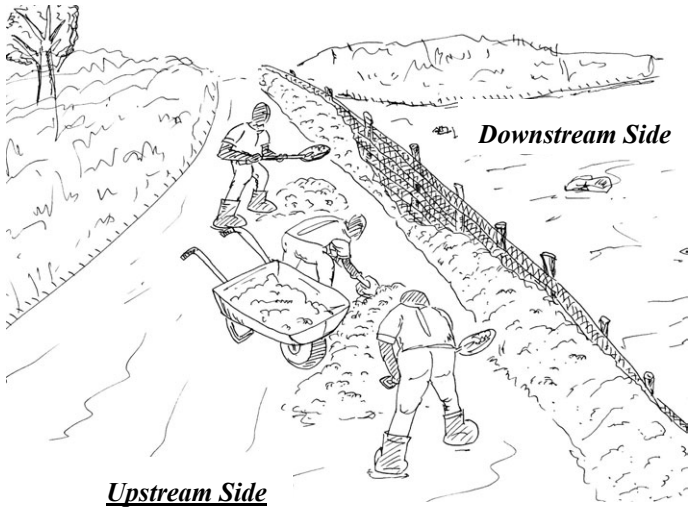
Assembling of the Trigonal Prop (An Example tried in Japan)

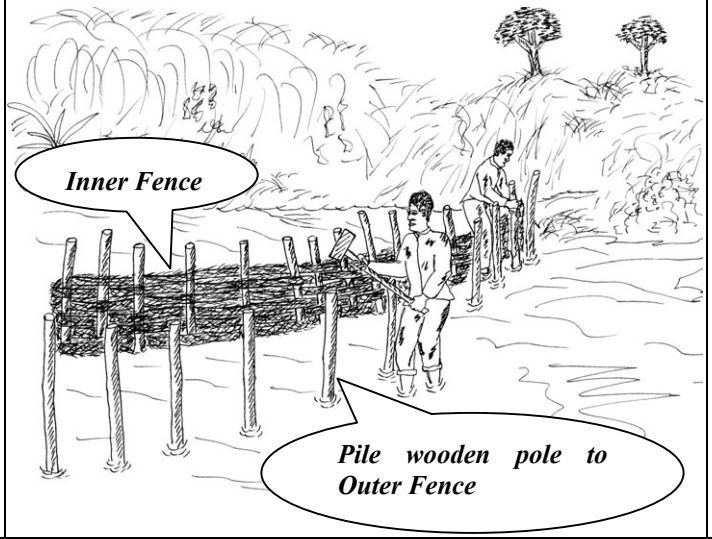
Step	*Bad Samples of Making Knot*	*Remarks*
	 	*In Japan, trigonal supported weir had long been tried in some of the rural areas up until some decades ago. The trigonal weir is traditionally called Ushi-waku (cattle frame), and stones packed in bamboo net were sometimes placed on the horizontal members of the trigonal to stabilize and to be more resistant against water pressure (see above Illustration).* *In a relatively big scale, Sei-gyu (holly cattle) as shown in Illustration below was sometimes tried. Sei-gyu has a long support log to prop up the weir body against water pressure, along which triangular stand structures are positioned. Weight that is in most cases stones packed in gabion net had also been added to make the structure more resistant against the water pressure.* *However, the higher the water level is raised, the more risk the weir faces to collapse. Therefore, weir which height is more than our neck shall not be constructed.*

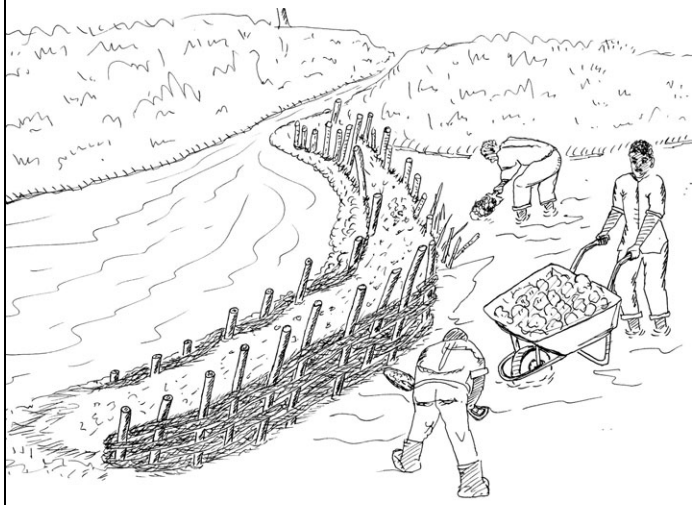
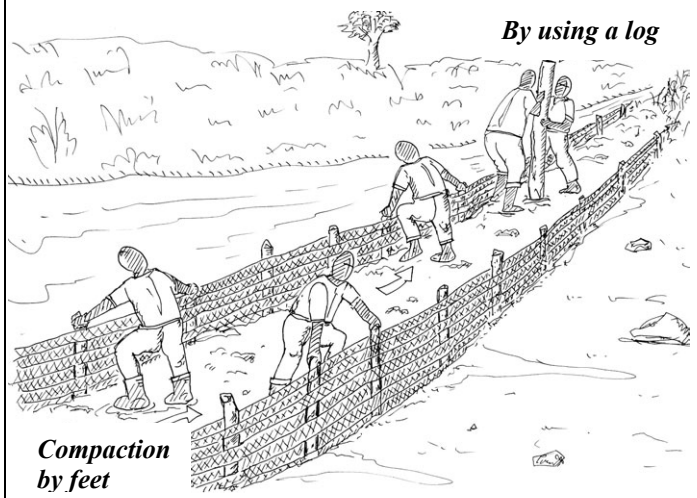
4. Construction of Brush Dam having Double Lines (Type-D)

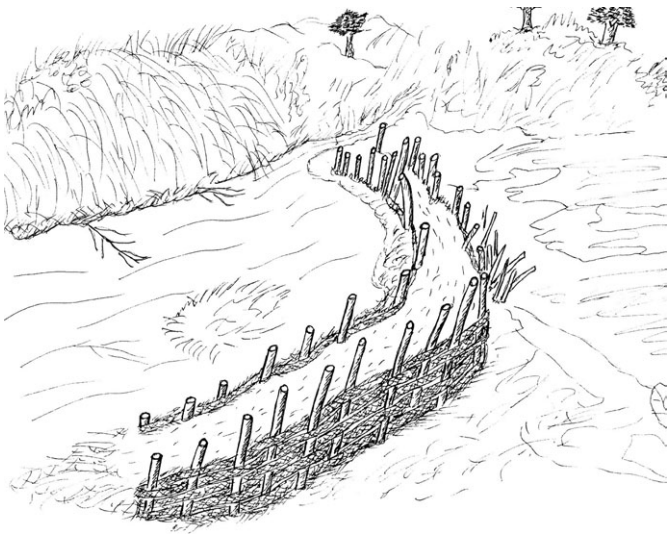
Step	*Materials to be collected*
0	***Collect all the following materials**;* *(a) Log/Bamboo/Twigs: to make the fence both inner and outer (Quantity: 30-35nos. per 10 meter length of the Dam, Refer to Step-1 & 5)* *(b) Grasses (Elephant grass): to weave into the fences (Quantity: depend on size of the 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 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.*
	

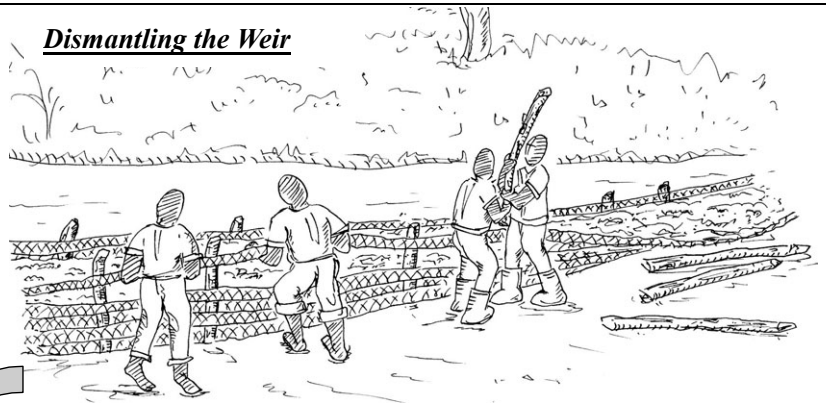
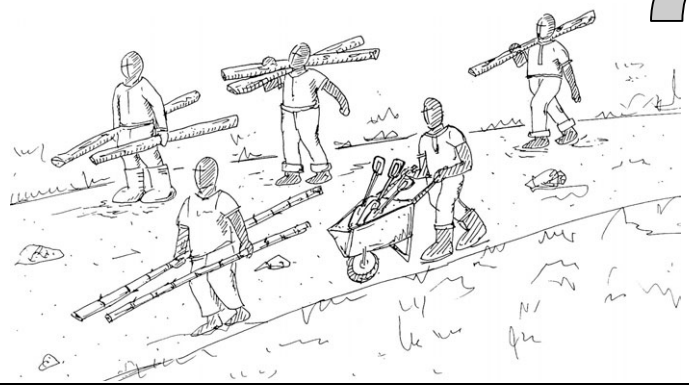
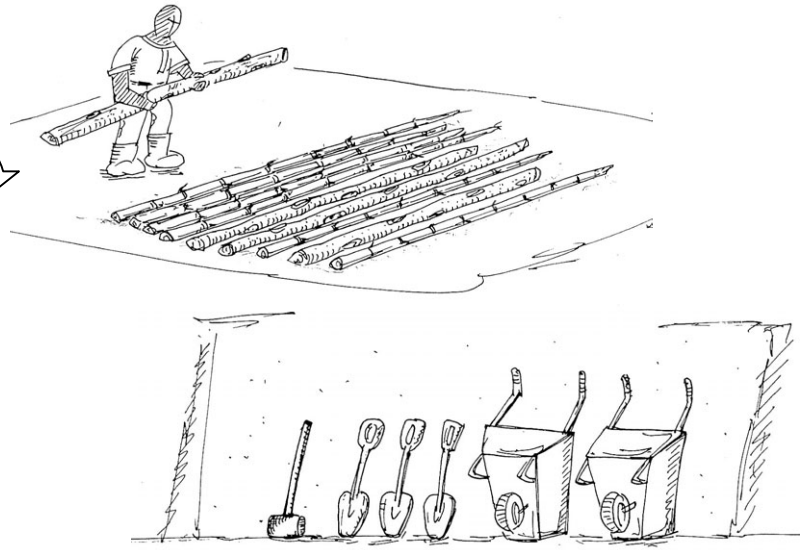
Step	Process	Description	Remarks
1		***Pile Wooden Poles to the Inner Fence (Upstream Side);*** *To make the inner fence, the wooden poles such as log, bamboo and twigs are piled on the line crossing the stream.* *When the poles are properly positioned, they are driven into the streambed by a hammer.*	*In case of a site in Kasungu district, the length of the diversion weir is 13.5 m. About 20 of wooden poles were piled at 0.5 - 0.7m interval. The bed material of the stream is composed of sand of 0.4m of thickness. Then, the poles were hammered into the ground with 0.4m of depth. Length of the pole is cut depending on site condition and in relatione to the design tapping water depth. In case of the site, the poles having 1.3m of length were used for 0.8m of tapping water depth.*
2		***Weave Grasses into the Inner Fence;*** *To tap the stream flow, grasses (elephant grass etc.) are woven horizontally into the inner poles following Step-1.*	*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. (See next Step-3)*

Step	Process	Description	Remarks
3		***Compact Grasses by Feet;*** *The grasses are compacted by feet in order to achieve a water tight situation.*	*The grasses which are weaved into the poles are pressed 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.*
4		***Put Clay/Ordinary Soil on the Inner Fence;*** *Furthermore, clay/ordinary soils are put on the upstream side of inner fence to prevent from being water 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 foundation level. Clay/Ordinary soil put on the grass fence for prevention of water leakage was hard to obtain.*

Step	Process	Description	Remarks
5		***Pile Wooden Poles to the Outer Fence (Downstream Side);*** *The outer fence is constructed as follows following Step-4. As first step of making the outer fence, the wooden poles are piled on the line of outer fence such as Step-1.*	*The poles were 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 inner and the outer being 0.5m - 0.7m*
6		***Weave Grasses into the Outer Fence;*** *Same as Step-2, grasses (elephant grass etc.) are woven horizontally into the outer poles.* *And secondary, grasses are compacted by feet/ or using a log in order to achieve a water tight situation.*	*The grasses are compacted by feet same as Step-3.* ***Compaction grasses by feet*** 

Step	Process	Description	Remarks
7		***Stuff Clay/Ordinary Soils;*** *Put the soil which exist around the site into the opening between the inner and outer fence especially the upstream of the weir. The clay soil is collected around the diversion site.*	*To prevent water leakage from the grass fences, clay/ordinary soils are put into the space between the inner fence and outer. The clay soil is collected around the diversion site. The clay and ordinary soil thrown into this space is compacted heavily by feet (See below)..*
		*Refer to the Illustration* *The soils stuffed into the space between the inner and outer fence are compacted physically by feet, and also using a log is available.*	***Compaction soils by feet*** 

Step	Process	Description	Remarks
8		***Completion of Construction*** *After all the process is followed, the weir can completed and water starts backing up on the upstream of the weir before the water gets into the diversion canal to flow.*	*The dimensions of the weir shown in the last page are as follows;* *-Length of the weir: 13.5m* *-Height of the weir: 0.95m* *-Depth of tapped water: 0.85m*
		***Note; Maintaining the Weir*** *During operation of the irrigated farming, the diversion weir should be maintained carefully. For instance, if the hole is found on the weir it should be immediately stopped by sealing with clay/ordinary soil. This process will restore the weir its former good shape.*	

Step	Process	Description
9	***Dismantling the Weir***  ***Washing the Tools***  ***Transporting Materials & Tools to the village*** 	***Note; Dismantling the Weir and Set Aside the Main Materials*** *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.* ***Setting aside the Materials & Tools*** 

The Exterior of Brush Dam having Double Closure (Type-D)