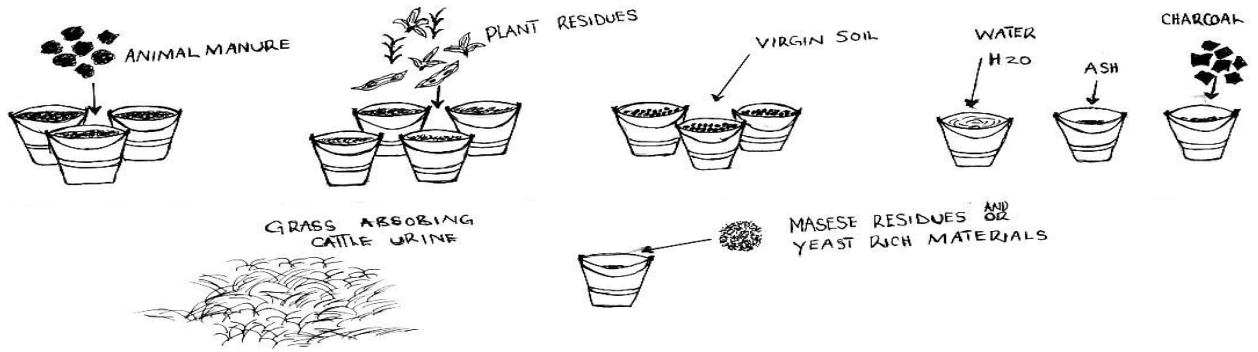
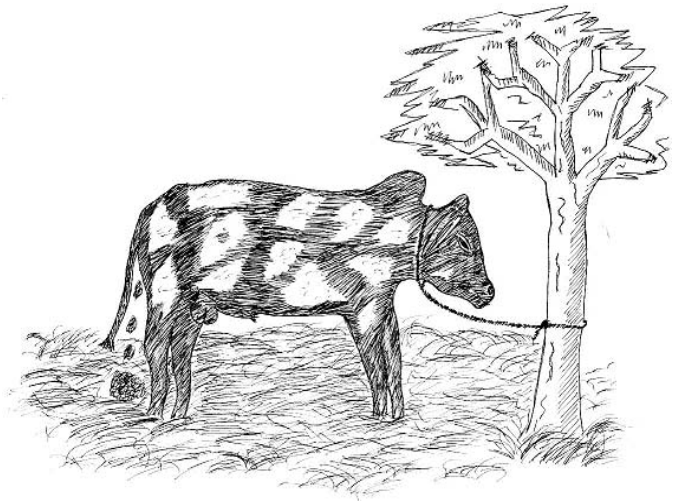
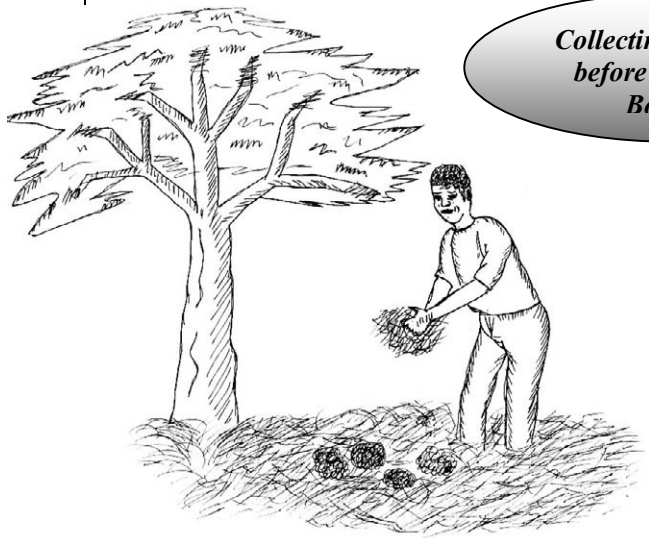
12. Bocashi, a Type of Quick Making Compost Manure

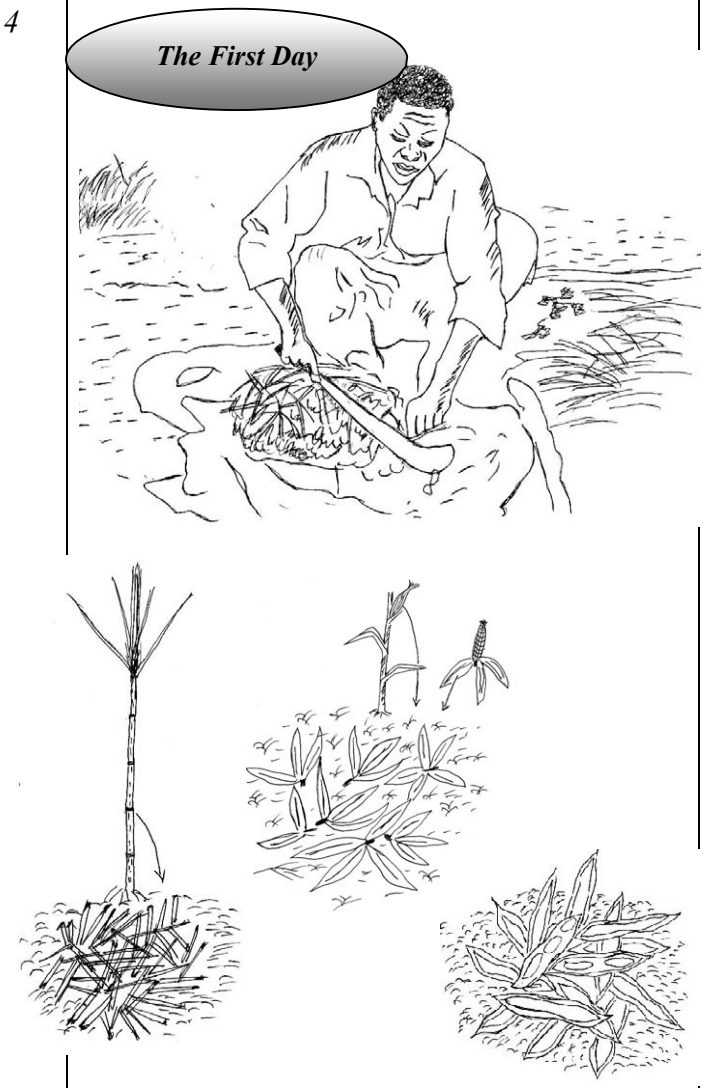
Step	*Materials to be collected*	*Remarks*
0	***Collect all the following materials for one heap**;* <u>*Materials absolutely necessary*</u> ・ *Animal manure: 3 pails* ・ *Plant residue: 4 pails* ・ *Virgin Soil: 3 pails* ・ *Water: Necessary to activate microorganism's activities which decompose organic materials to makes compost.* *Materials preferably added* ・ *Yeast rich Materials: One or some of followings* *1) Chibuku/ Masese residue: a half pail* *2) One portion of Bocashi previously made: 1 pail* *3) Dry yeast for making bread: a half of teaspoon mixed with 500 ml of water if possible add a spoon of sugar.* *4) Banana peal, rotten fruits or the other fruit residues: a half - 1 pail soaked in water.* <u>*Materials added if you have*</u> ・ *Ash: A half pail, It is mainly for pH control of Bocashi. It also provides K and the other minerals. However, don't burn plant residues for it, because if you burn the plant residues, you lose N and C from it, which are important nutrients for making compost. If you find it in cooking stove, add it.* ・ *Charcoal: A half pail, Break down into small pieces to be mixed with the other materials. It is a kind of microbes' house, which means that it can provide spaces (microspores of charcoal) to increase effective microbes' population.* *This proportion of materials is recommendable, however, it can be changed depending on availability of each materials. But % of soil should not be more than 30 % of all materials even though soil is always available. If the compost contains too much soil, it becomes heavy while nutrient contained in the compost is less.*	*Animal manure, plant residues, virgin soil, and water are necessary, while about other materials if you don't have these, these are not necessary. If you follow the procedures, you get quick make compost.* *Yeast rich materials give the compost quick effect. If you don't add it, the effect of compost appears as slower as the conventional compost, but at least you get quick make compost.*
		

Step	Process	Description	Remarks
1		***Collect animal manure;*** *Tie the livestock in your khola / garden during night and put plant residues and grass under the animals.* *In the morning, collect the dung and plant residues/grass, which has absorbed animal urine, and put it in a pit. To reduce evaporation, pour water in the pit and cover the pit with plastic sheets, banana leaves and so on.*	*Animal manure including urine, dung, and droppings are one of the sources that can increase soil fertility. They are very rich in nitrogen.* *Chicken or other bird droppings are one of the best materials because they highly contains nitrogen and the nitrogen which is in it, does not easily evaporate, compared to dung of cattle and other livestock. Additionally, it contains a lot of phosphate.* *About cattle and other middle and large size livestock, their dung / urine is rich in nitrogen only when it is fresh. But if it is dried up, most of it is lost due to evaporation.* *Urine contains a lot of nitrogen (ammonia) than dung, however, it is very difficult to collect it and utilize it.* *In this method, we can collect high quality animal manure so that we can make high quality compost from less amount of animal manure.*



Collecting Materials before making of Bocashi

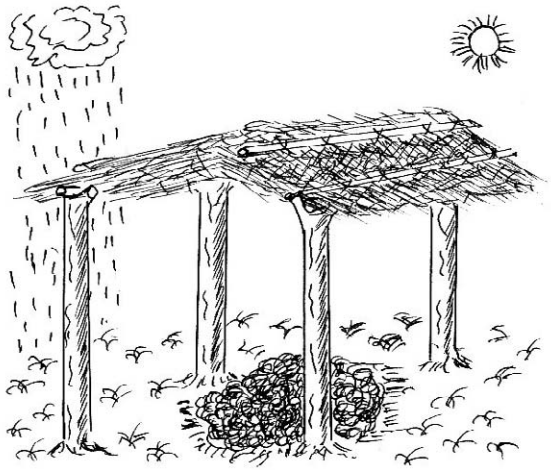
Step	Process	Description	Remarks
2		***Collect virgin soil;*** *Collect soil from virgin land that has never been planted to any crop before but has a good plant-ground cover (e.g. dambo or forest soils) or from orchard (e.g. under banana trees).* *Such kinds of soil contain a lot of active microorganisms to facilitate decomposition of the materials of Bocashi.*	*Soil is added because we want to add microorganisms to decompose organic materials. Additionally, soil absorbs nitrogen in the materials and fixes it, which means that it reduces the nitrogen loss in the procedure of making Bocashi. Thus, soil should contain a certain amount of clay which quickly fixes nitrogen firmly.* *Farmland soil is not good because it is always exposed to sunshine. UV from the sunshine kills most of effective microorganism, and the soil is too dry for their activities.* *Most of times farmers make compost using a lot of soil. This makes it very heavy to carry and again the concentration of nutrient is very low.*
3		***Collect Yeast rich materials;*** *Collect Chibuku/ Masese residues, which contain a lot of yeast.* *If you cannot find Chibuku/Masese residues, use a part of Bocashi that somebody has already made or sweet fruit residues. Those materials also contain a lot of yeast.* *Sweet fruit residues soak in water for 2-3days on order to let yeast multiply. Generally, yeast is found on surface of fruits.*	*During the decomposition procedure, yeast takes nitrogen from the materials, and uses it for their body growth.* *The nitrogen in their body of the yeast is mainly in amino acid form which is water-soluble and as a result plants take and utilize it easily, and this means that the effect of the compost appears relatively rapidly. On the other hand, this means that the nitrogen in Bocashi is easier to leach out or to evaporate than the nitrogen in conventional compost.* *Yeast's body also contains rich vitamins which accelerate plant growth.* *Yeast works as a nitrogen storage as well as a clay part. Yeast releases nitrogen in Bocashi compost rapidly, while clay releases slowly.*

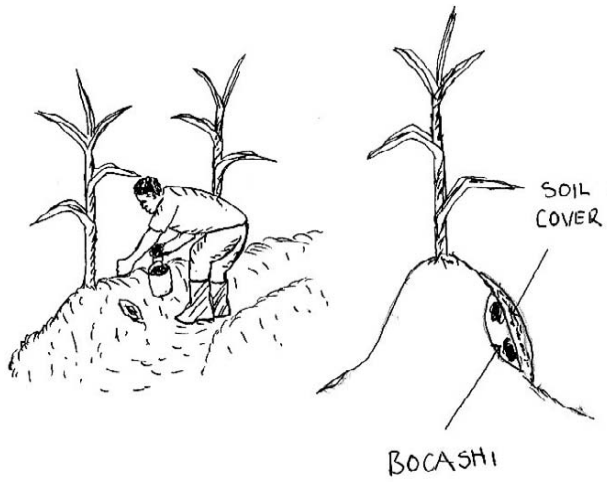
Step	Process	Description	Remarks
4		***Prepare plant residues;*** *Cut the plant residues into small pieces in order to make it easier to mix with other materials and to facilitate decomposition.* *Plant residues to be prepared are cobs of maize, pod of beans, maize bran, sugarcane residues, and other plant bodies.* *The plant residues contain C, N, K, and the others. The plant residues are good nutrients for plants, energy source for microorganism, and they are decomposed into manure form which is good in contributing to holding appropriate moisture, making chemical fertilizer's effect longer and the other good soil physical characters.* *The plant residues are also useful to improve aeration in the heap, preventing a heap from compaction by its weight. The plant residues should therefore be not only good energy source for microorganism but also materials for aeration improvement. Chose the materials and mix them considering the both points.*	*Carbon in plant residues is good in contributing to improve soil physical characters.* *Legume residues are recommendable because they are rich in nitrogen. However, the legume leaves are easy to decompose so that on the bad side of it, the nitrogen is easily lost. Thus we should collect fresh materials to avoid losing the nitrogen easily. It should Also, be noted that the leaves are not good for aeration of the heaps.* *Maize bran is also recommendable, because this material is another good energy source for microorganism and is useful to increase yeast population.* *Sugarcane residues are also recommendable because they contain a lot of sugar. Sugar is a very good source of energy and it is in easily usable form such that it is easily taken by microorganisms, which in turn means that microbe's activities are accelerated.* *Leeds residue does not easily decompose. Therefore it is not usually recommended. However, from the viewpoint of aeration, it could be good one. Other materials improving the aeration are maize cob, ground nut pods, rice chaffs, etc.*

Step	*Process*	*Description*	*Remarks*
5		***Mixing each materials;*** *Mix the small portion of each materials together.*	*If there are a lot of materials, don't mix the materials at once because it is difficult to mix them properly. Take a certain portion of each material, mix them thoroughly, and put them into a good place.*
6		***Pour water on the mixed material;*** *Pour water in order to have appropriate moisture content. Be sure of not too wet and not too dry. Ensure that all the materials are moist and water added equally to all over materials as you are mixing.*	*You can know you have good moisture content when you take a portion of mixed materials in your hand and you hold it firmly in your palm, and when you release your palm it is in a ball shape. But when you shake it in your hand it breaks easily. If this is achieved, you have a good moisture contents.*

Step	*Process*	*Description*	*Remarks*
7		***<u>Piling the mixed material with suitable moisture;</u>*** *After adding appropriate moisture, pile it on some place, and then repeat again the mixing procedure as above-mentioned.* *Continue the procedure until all materials have been finished.*	*Don't compact the materials as this reduce free air circulation, which is essential for this compost.* *With appropriate moisture condition without compaction, aerobic microorganisms can get enough water and enough air for their activities. Generally, decomposition speed of aerobic microorganisms is more rapid than anaerobic one. With this fact in mind, in our Bocashi, we try to promote aerobic activities.* *On the contrary, in conventional method, we add a lot of water at first and then compact it. This process, of putting too much water and then compacting it, reduces air circulation and hence create a good environment for anaerobic microorganisms to take over. Of course anaerobic microbes also decompose but the decomposition processes is very slow.*
8		***<u>Cover the finished pile;</u>*** *Cover the finished pile with banana leaves or plastic paper. This helps to maintain proper moisture and prevent UV of sunshine from killing the microbes.* *Keep it in mind that water in Bocashi is easy to dry up, while water in Chimato method and conventional pit compost methods does not evaporate easily because all materials in these methods are compacted, and then covered with clay or put into a pit.*	

Step	Process	Description	Remarks
9-1		***Keep appropriate temperature;*** *After 1-2 days, the temperature of the materials rises up to more than 60 degree centigrade. This high temperature kills the effective microorganism. Thus, often check temperature of the heap to avoid the temperature reaching this deadly level.* *The process of checking is simple: 1) stick a panga into the heap, 2) count until ten, 3) pull out the panga, and then 4) touch it to see the temperature. If it is too hot, break down the heap in order to decrease the temperature. When the temperature decreases to normal say 30-45 degree, make heap again and cover it again. After that, still check the temperature often. When finding the temperature rising too much, repeat the procedure.* *Simultaneously, as you are checking the temperature, also check the moisture. If it is too dry, add water.* *Take care about temperature and moisture once or twice a day during first week (of course, this depends on the situation).* *Avoiding high temperature on the other hand cannot kill disease viruses that might be in the material. Therefore if there is a prevalent epidemic in the area, this Bocashi may be suspended.*	*These procedures are different from the conventional compost making. In conventional methods, we leave the rising of the temperature of materials, and in so doing most effective microorganism die once.* *After the temperature has decreased to favorable temperature, other microorganisms come in and start to work/ decompose again, which means that it takes a lot of time to complete the decomposition process. This process, whereby microbes die, makes the conventional method very slow to mature.* *On the other hand, high temperature in conventional methods is effective to kill plant pest. Thus, if you use plant residues which had got plant pest in last cultivation, conventional methods is recommendable.* *The materials are sometimes compacted by self-weight. If you find this scenario, break down the pile so that air should circulate within it and after few minutes remake the heap. To reduce this risk, that is to improve the aeration in the materials, add a lot of plant residues.* *In Bocashi method, farmers have to check everyday the heap. By checking the temperature everyday, farmers' interest in the Bocashi can be aroused and even increased, while in conventional methods farmers' interest is sometimes decreased by the time the compost is ready.*
9-2			

Step	Process	Description	Remarks
10		***Now ready to use;*** *After 2-3 weeks (depending on the situation), the compost, Bocashi, is ready to use. Spread all the materials and dry it under shade in order to stop the decomposition. Should not continue the decomposition when you find color of all materials has changed into dark.* *The conventional methods take 2-3 months, while in Bocashi method it takes 2-3 weeks, because we have good quality materials, and keep good conditions (not too dry, not too hot, sufficient air) for effective microorganism activities.*	*If you find the color of all the materials has changed into dark, then no more decomposition is needed, and we should stop the decomposition immediately, because if the decomposition process continues, nitrogen in the Bocashi changes into other forms. Some of them change into forms that can easily evaporate, some of them change into fixed and water insoluble forms, which makes it difficult to be used by plants.*
11		***Keeping the Bocashi;*** *Keep it dry avoiding sunshine.*	*Bocashi should be kept in dry condition, because if it becomes wet, decomposition will start again. In decomposition process, nitrogen in Bocashi sometimes evaporates and sometimes changes into slow acting form.* *Bocashi contains a lot of useful microorganisms. Therefore, UV from sunshine should be avoided in order not to kill microorganisms.*

<table>
<tr><th>Step</th><th>Process</th><th>Description</th><th>Remarks</th></tr>
<tr><td>12-1</td><td> 
</td><td><u>Apply Bocashi;</u>
Bocashi is used both as basal- and as additional- fertilizer.

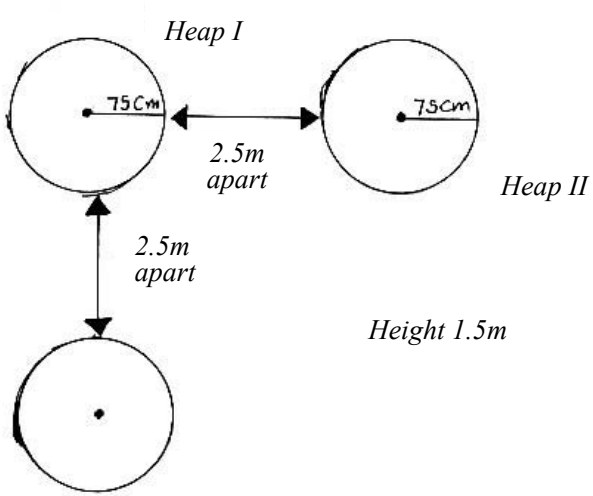
If you apply Bocashi as additional-fertilizer, a grasp of Bocashi is generally applied to each plant. Top-dressing method is not appropriate, while making a hole to apply it and earthening up with Bocashi is recommendable.</td><td>Being same as above-mentioned, UV from sunshine kills useful microorganism. Therefore, application methods of Bocashi should be avoiding sunshine.</td></tr>
<tr><td>12-2</td><td colspan="2">Amount of Application
✓ Application of chemical fertilizer for maize cultivation Reference : TIP Program
・ 23:21:0-4s : 50 kg / ha
・ Urea : 50 kg / ha
✓ Amount of each nutrient applied
・ N : 33 kg / ha
・ P : 10.5 kg / ha
・ K : 0 kg / ha
✓ If we want to add same amount of nutrients, we should add (/ha), based on N amount,
・ 33 kg / 2.05 % =1609.76 kg of Bocashi Compost
✓ If the weight of one heap of compost is 20kg, we need
・ 1609.76 kg /20 kg = 80.49 heaps
✓ About the other nutrients added
・ P : 1609.76 kg X 0.04 % = 0.64 kg
・ K : 1609.76 kg X 0.43 % = 6.92 kg
✓ If we want to add same amount of nutrients of chemical fertilizer, we should additionally apply (/ha),
・ P : 10.5 kg – 0.64 kg = 9.86 kg
・ K : 0 kg – 6.92 kg = - 6.92 kg
✓ In Japan, the amount of Compost application recommended is;
・ 5,000 kg / ha (Cattle Dung Compost)
Generally, the main object of compost application in Japan is to improve soil physical characters.</td><td>Nutrient contents of Bocashi Compost and Compost
<table><tr><th>Type</th><th>Data comes from</th><th>% N</th><th>% P</th><th>% K</th></tr><tr><td>Bocashi (Cattle dung)</td><td>Chitedze Research Center</td><td>2.05</td><td>0.04</td><td>0.43</td></tr><tr><td>Compost (Cattle dung)</td><td>Japanese Average</td><td>1.6-2.1</td><td>1.5-3.5</td><td>2.0-4.0</td></tr></table>
If you would like to make P-rich compost, chicken droppings are recommendable as animal manure.</td></tr>
</table>

Step	***Extension of Compost***	
13	*Malawian Agricultural sector promotes compost in recent years, but the compost still is not expanded yet.* *Why do farmers not use compost?* ・ *Long time to produce* ・ *No time to make compost/ Need lots of work* ・ *They don't have enough animal manure* ・ *Difficulty to transport* ・ *A little effect / Slow effect (Comparing with Chemical fertilizer)* *And also farmers are not well aware of why they should apply compost to farmland. Many of farmers say, "Now I don't have money so that I use Compost. But if I get money, I will use chemical fertilizer."* *The reasons to use compost are 1) To add fertility to soil, 2) To improve soil physical characters, and 3) Cheap and made of locally available materials. The most important reason, 2) To improve soil physical characters, is not seriously taken by farmers yet. If farmers realize the effect of improving soil physical characters, farmers regard compost as more than an alternative of chemical fertilizer and they may use it more eagerly.* *How do we explain the effect of improving soil physical characters? One method is to let the farmers realize the situation of soil in farmland. Even though farmers know the soil productivity decreases year by year, we try to let them well realize the effect again. We will tell them why we should apply the compost to farmland not as an alternative of chemical fertilizer but to improve the soil character.* *Here we have some examples to explain it.*	
Step	***Process***	***Dialogue***
13-1	*First, go to the farm, and show the soil in the farmland. Generally, the soil in farmland has some debris of the plant residues, pick up these residues and show them.*	*"Farmland has generally plant residues and the other organic materials, which improve the soil physical characters, for example, to increase soil absorption, to make soil soft, to add soil nutrients and so on. If we continue to cultivate in farmland, what happens? We rapidly lose these plant residues and organic materials, because the some of them are consumed by crops, some of them are washed away by rain, some of them are brown away by wind, some of them are burned out. What happens next?"*

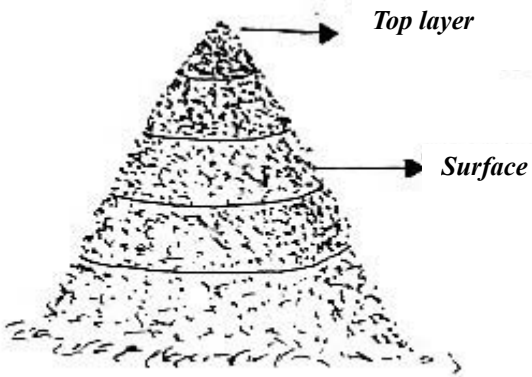
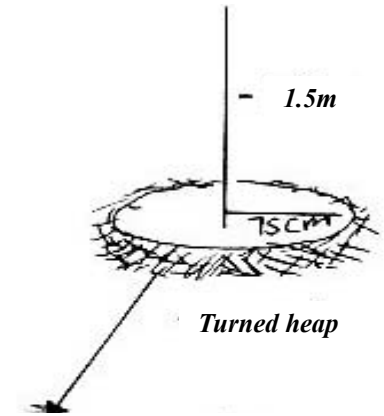
Step	***Process***	***Dialogue***
13-2	*Go to some place where the soil doesn't have organic materials and the surface of the soil is hard (ex. some soil in farming road). Or remove soft surface soil in the farmland until we can see the hard layer.*	*"This is the soil without plant residues and organic materials. It is too hard for plants to extend their roots."*
13-3	*Pour water to the soils. Water doesn't absorb and go away rapidly to lower place.*	*"If we add water to soil, water flows away rapidly. It is not absorbed into soil."*
13-4	*Stick a small branch of trees or so to the soil, liken to maize.*	*"This is a maize crop, Now we irrigate."*
13-5	*Pour water. Water flows away rapidly.*	*"With this kind of soil, water goes away rapidly, and when the crop tries to drink water, it has already gone."*
13-6	*Put some small stones around the crops, liken to chemical fertilizer.*	*"If you apply chemical fertilizer into soil, generally, chemical fertilizer is dissolved to irrigation water first, and then plant drinks the dissolved chemical fertilizer in irrigated water. But in such kinds of soil, chemical fertilizer dissolved in water goes away rapidly and crop cannot drink it. Even though you add much chemical fertilizer, plant can take only a little amount of fertilizer."*
13-7	*Saying;*	*"What should we do now? We should add some organic materials into the soil."*
13-8	*Make small balls with toilet paper/ old texture liken to compost and put them around the stick liken to maize.*	*"This is compost. We apply near the maize. Now, water is absorbed into that compost and stays around maize, so now crop can drink water and also can take chemical fertilizer dissolved in water as well. The compost is a kind of sponge in the soil and the role is very important, OK?"*

13. Chinese Compost Manure

Step	*Materials to be collected*
0	***Collect all the following materials**;* • *Plant residues such as maize stovers, grass and/or any other materials (legume materials should also be among the materials to be used.)* • *Water supply should be nearby.* • *Animal manure i.e. cow dung, chicken dropping, etc (Chicken manure or bird manure have high nitrogen content than cattle dung or livestock manure. This is so because droppings contain urine in them, so decomposition tends to increase.)* • *Virgin soils* ***Implements;*** • *Shovel* • *Panga Knife* • *Watering can* *Chinese compost requires about one month to be decomposed; that is shorter period than conventional pit compost which takes about 3 month or more and Chimato compost (about 2.5 months), but still longer than Bocashi. In terms of nutrients in the compost as well as quickness to decompose, Bocashi could be the best. However, if farmers face problems to collect necessary materials for Bocashi, they can change from Bocashi to this Chinese compost or even something like mixture of the two methods.*
	

Step	Process	Description	Remarks
1		***Prepare necessary materials:*** *Collect necessary materials such as plant residues, animal manure, virgin soil, etc.* *Cut the plant residues into small pieces.*	*Virgin soils are recommended because they contain a lot of microorganisms which are important for the decomposition process.* *To collect fresh animal dung, refer to the method described in Bocashi making procedure.* *The cutting process is good at this stage as the cutting increases the surface area at which the microorganism works.*
2		***Align the base for manure:*** *Clear the area for heaping the compost preferably under the tree or shade to reduce evaporation and rapid loss of nutrients.*	*The size of the radius should be around 75 cm and the initial height of the heap to be made should be approximately 1.5 meters.* *If more than one heap of compost is to be made, clearance distance of 2.5 meter should be observed from one heap to another.*

Step	Process	Description	Remarks
3		***Make manure heap:*** *Spray 3 shovels of animal droppings i.e. dung, chiken droppings etc thoroughly on the circle.* *Take the plant residues and spread them over the manure to a height of 15-20cm*	*Water the residues thoroughly. Three full watering cans are enough.* 
4		***Continue the heaping:*** *Have 3 shovels of animal manure spread over the watered layer of compost. After this, spread two shovels of virgin soils on top and sprinkle some water on it. And this should be directly followed with another layer of 15-20cm of plant residue.* *Continue doing this process by putting layer by layer of the materials mentioned above until a height of 1.5 m is achieved.*	*Make sure the heap is made in conical shape so as to avoid the heap from falling due to its own weight.* *It is encouraged to make these heaps at the farmyard to reduce transportation labor.* *Eight heaps of this size will be enough for one acre.*

Step	Process	Description	Remarks
5	 ***First Heap***  ***Turned heap*** ***Surface scrapes and top layer of the bottom***	***<u>Turning of the compost heap:</u>*** *Turning should be done after 5 days from the heaping time. When turning, the compost's first scrap, which are exposed to the sun and are assumed to dry up, should be at the bottom of the next heap to be made.* *The top layer and the surface scraps are to be placed at the bottom, or the first layer of the next heap. Continue taking layer by layer of the old heap and putting it into another heap as described above.* *The scenario should be that, the top layer and those on the sides of the old heap should be at least at the bottom of the new turning heap.* *The turned heap should also be conical in shape. Make sure that there is adequate moisture since decomposition cannot take place without water.*	*The procedure of heaping during turning is the same as in the first heaping, only that the amount of water used tends to reduce. However the first layer in turning should receive 3 watering cans of water since the materials were exposed to rapid evaporation.* *Animal manure should only be added in the first turning especially if it is noticed that a particular layer didn't have enough of it. If you add to that layer, more water should also be added to that particular layer to fasten decomposition.* *Turning is done every 5 days for 6 weeks. The materials will be fully decomposed after 35 days giving an allowance of 1 week for those, which were not fully decomposed. The finished compost will be dark in color.*

Step	Process	Description	Remarks
6		***<u>Checking the temperature:</u>*** *There must be some heat felt during turning. The temperature tends to increase rapidly when the outside temperatures are high. This shows that microbial activity decomposing the residues are going on. So it is important to check the heat especially from 3rd turning. There will be steaming smoke seen during the morning hours. This is also another sign of decomposition.*	*To check the temperature in the heap, take a Panga or a good size stick and insert it in a heap and wait for it for a few minutes. Then take it out and feel on your arm, and if it is hot, know that decomposition is taking place.*

14. Liquid Fertilizer

Step	*Materials to be collected*
0	***Collect all the following materials for making a container of liquid fertilizer**;* ・ *Chicken droppings, and/or any other bird droppings: one third to half of a container (or a bottle)* ・ *Container, or any other bottle (preferably more than 1 litter)* ・ *Water*

Chicken droppings and birds droppings are one of the best materials to make manure since these highly contain nitrogen, phosphorus, and potassium. The nitrogen in the droppings does not easily evaporate as compared to cow and other livestock dung, which is very advantageous in making manure.

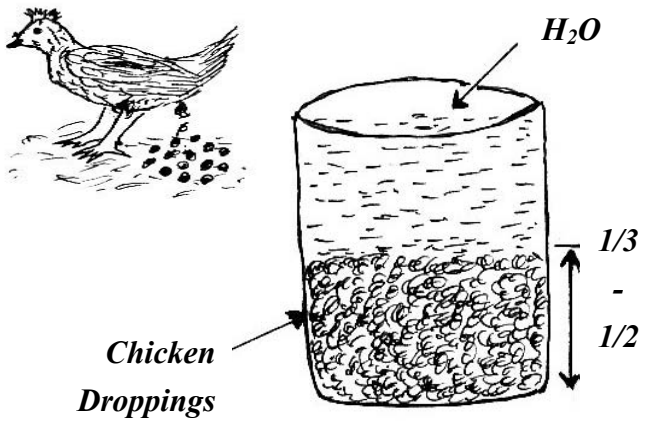
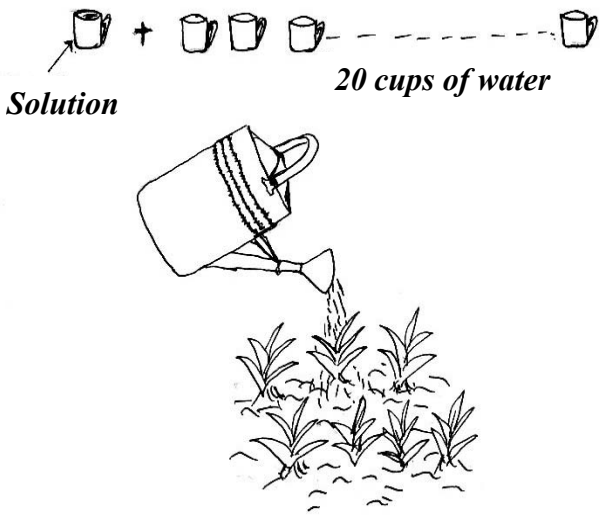
	N(%)	*P(%)*	*K(%)*
Chicken dropping (Dry)	***3***	***3.1***	***1.3***
Cow dung (Fresh)	*0.3*	*0.4*	*0.1*
Cow urine (Fresh)	*0.8*	*0.1*	*1.5*

Source: "Manure Manufacturing Study (1981)", "Introduction of Manure Study, Second edition (1960)"

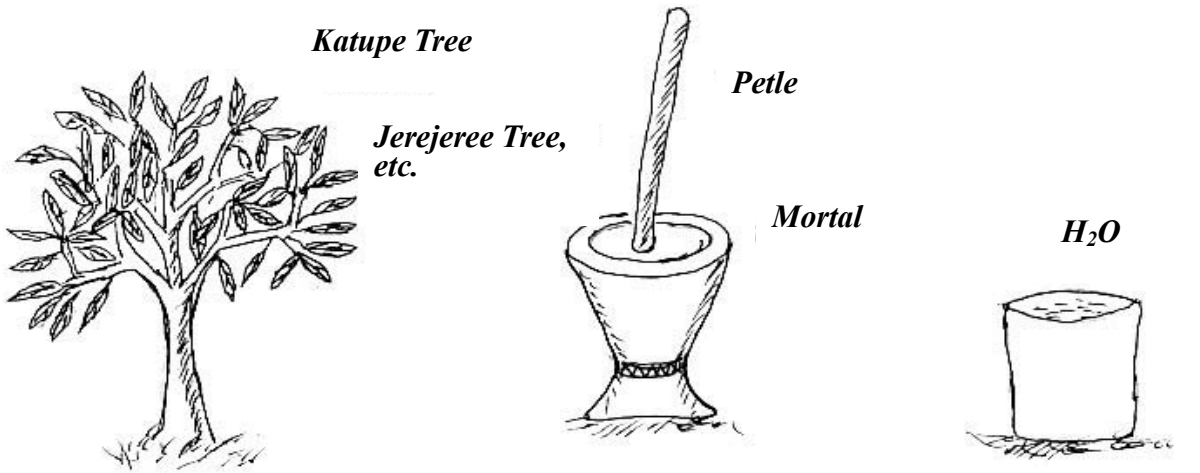
Differences in quantity of N, P and K (refer to right table) are due to: 1) In metabolism procedure, every animal produces toxic by-product, ammonia, and should discharge it. Mammal discharges as ammonia form in urine, which is easy to evaporate. Bird discharges ureic acid form with feces, which is solid and is difficult to evaporate, and 2) Eating habit of each animal has influences on chemical component of their manure. Generally, manure of carnivorous animals contains more N and P than herbivorous animals'.

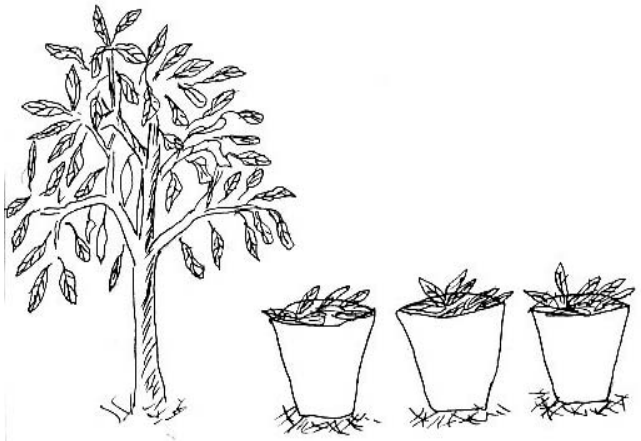
Following table shows characters of liquid fertilizer, conventional compost and chemical fertilizer. As same as chemical fertilizer in terms of fertilization, it is quick to make the fertilizer and the effect will appear rapidly in short time, unlike conventional compost manure. Noted is that the liquid fertilizer does not have any effect of improving the soil physical character and the nutrient effect doesn't continue for more than a few days, reminding the farmers of still applying compost manures. Therefore, liquid fertilizer should be used in combination with other compost manure.

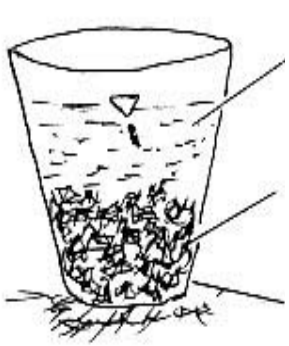
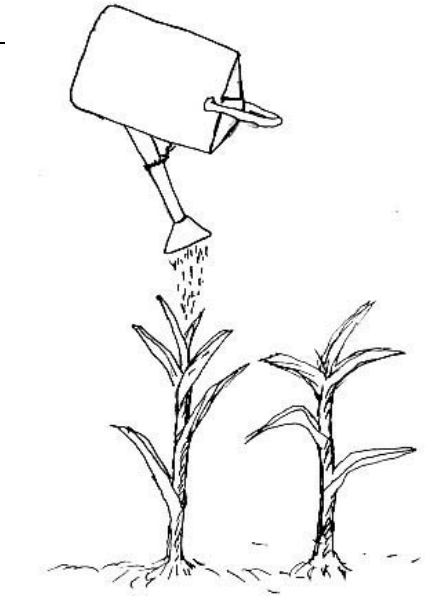
Specification	***Liquid fertilizer***	*Conven'l compost*	*Chemical fertilizer*
Time to make	***1 week***	*2 – 3 months*	*-*
Time to see the effect	***rapid***	*late*	*rapid*
Duration of effect	***Very short***	***Long***	*Short*
Amount of fertility	>		*Very high*
Improvement of soil physical character	***Not effective***	*Effective*	*Not effective*

Step	*Process*	*Description*	*Remarks*
1		***Put collected droppings in water;*** *Put collected droppings in the container or bottle to one third to half of it, and pour water in the container.* *Then leave it for one week or so.*	*Nitrogen and potassium in droppings dissolve into water. Plants can take the nitrogen very easily. Thus, the effect of liquid fertilizer appears rapidly.*
2		***Apply liquid fertilizer;*** *After filtrated by used cloth, dilute the liquid with 15-20 times volume of water, and then put the diluted fertilizer on the plant by a cup or watering can. Generally, one cup of liquid fertilizer is applied for one plant (for a station).*	*The residue in the container should not be thrown away but be applied to the field or be used as a material for compost making since it has rich phosphate and could still contain nutrients that have not yet come out.* *Timing of application is almost same as chemical fertilizer application as additional fertilizer.*

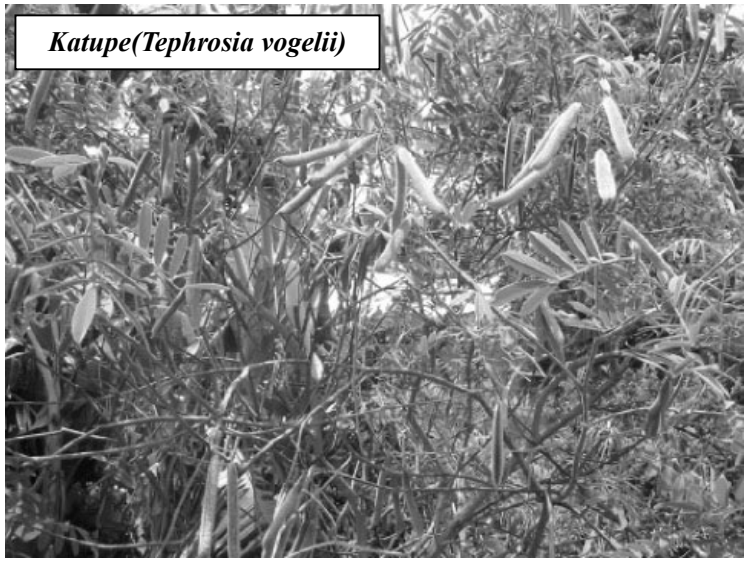
15. Botanical Natural Pesticide (Section 1; Botanicals)

Step	*Materials to be collected*
0	***Collect all the following materials for making natural pesticide**;* ・ *Leaves of Tephrosia vogelii (locally known as Katupe tree) and/or Sesbania sesban (locally known as Jerejere tree)* ・ *Mortar and pestle to crush the leaves* ・ *Bucket to sink the crushed leaved into water* ・ *Water* *Insect pests such as maize stalk borer, aphids, cabbage sawfly, other sucking pests, cabbage webworm, etc. can be found in many places. Though these pests can be controlled by chemical insecticides, most farmers unfortunately cannot afford to buy such chemicals. Instead, the farmers can use natural tree leaves which contain rotenone, tephrosin and deguelin. The extracted ingredient works as botanical insecticide. The half-life of these elements dissolved in 20 degree water is usually less than 1-day (Gilderhus et al:1982, 1991), and it is also decomposed easily under sunshine thus non-residual. However, it is recommended that vegetables applied with the botanical pesticides should be well washed before being eaten, and also irrigation water which contains such natural pesticides should not directory go back to the stream.*
	

Step	*Process*	*Description*	*Remarks*
1		***Collect leaves;*** *Collect leaves from matured Katepu tree and/or Jerejere tree.*	*Three full buckets (ndowa) of leaves would give us about 5 litters of solution, which in turn cover about 100 planting stations.* *Because effective compounds of this liquid are decomposed rapidly (generally, a half of the total amount is decomposed within 1 day), prepare this liquid just 1 day before the application. You cannot store this liquid for more than 2 days.*
2	 ***Crushing***	***Crush the leaves;*** *Put the leaves in a mortar and crush them by pestle, just like pounding maize to remove husks.*	

Step	*Process*	*Description*	*Remarks*
3		***<u>Put crushed leaves into water;</u>*** *Put crushed leaves in a pail and pour water. If three full buckets of leave are collected, about 5 liters of water can be used to dilute..* *Leave the water at least 24 hours to several days until the bio-ingredient is extracted. When the water color becomes greenish, it is ready to use. If the water color remains just transparent, add some more crushed leaves.*	*According to an experiment carried out under Lobi Horticultural Appropriate Technology Extension Project, one liter of water per 400 g of Tephrosia vogelii leaves has shown almost similar effect to malathion, which is a synthetic chemical insecticide.*
4		***<u>Pour the solution on the plant;</u>*** *After filtration with used cloth, put the solution on the plant by watering can or sprayer (watering can may need about double amount of the solution than sprayer).* *After spraying, observe the insecticides. If it is not subdued, spray again but denser solution is recommendable.*	*5 liters of solution covers about 100 planting sections though it is depending on humidity, temperature and population of the pests.* *About maize stalk borer, the insecticide should be applied to maize in young generation, in which height of maize is 15-20cm. Protection is more important than cure is.*

Photos



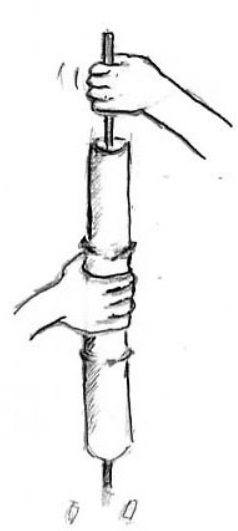
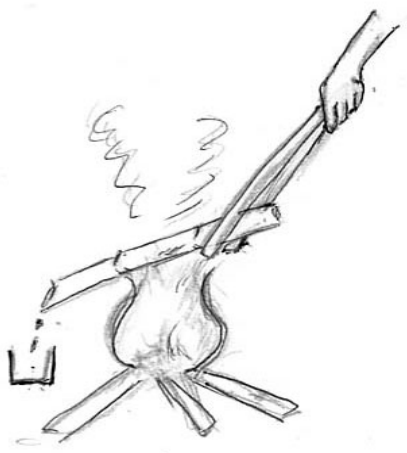
Katupe(Tephrosia vogelii)

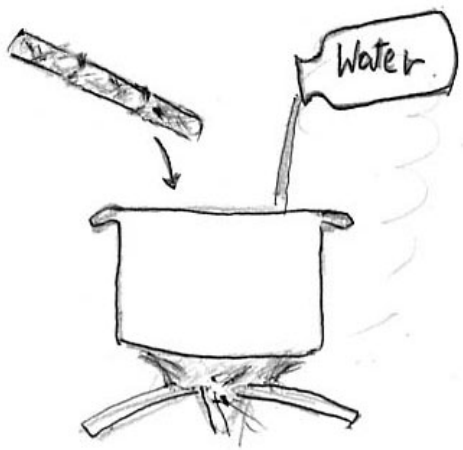
Katupe(Tephrosia vogelii)

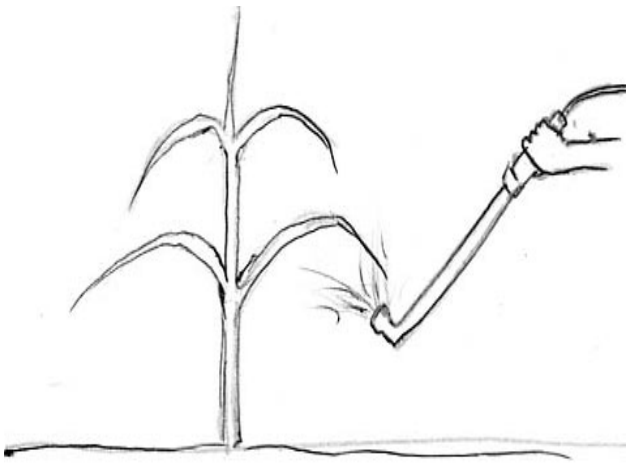
Jerejere (Sesbania sesban)

Jerejere (Sesbania sesban)

Botanical Natural Pesticide (Section 2; Bamboo Liquid)

Step	***Process***	***Description***	***Remarks***
1		***<u>Preparation of the materials;</u>*** ・ *Prepare 60 cm long bamboo. Break through all joints of it.*	
2		***<u>Collect Liquid 1;</u>*** ・ *Roast the bamboo. After a while, some liquid drops out from the cutting edge. Collect it into a can. More or less 30-40 cc of the liquid can be collected (Liquid 1).*	・ *While roasting, you can support the bamboo by a pair of tongs, put it on a gridiron or on a fireplace of cooking stove, and so on.*

<table>
<tr><th>Step</th><th>Process</th><th>Description</th><th>Remarks</th></tr>
<tr><td>3</td><td> 
</td><td><u>Making Liquid 2;</u>
・ Put 1 kg of roasted bamboo and 1.5 l of water into a pot and boil it.
・ Pour the liquid into some container (Liquid 2), and keep roasted bamboos, too.</td><td></td></tr>
<tr><td>4</td><td colspan="2"><u>Component of Products;</u>
<table>
<tr><th>Product</th><th>Component</th><th>Effects</th></tr>
<tr><td>Liquid I</td><td>Polysaccharides, Vitamins, Amino acids, Ions</td><td>Mainly to enhance the plant growth</td></tr>
<tr><td>Liquid II</td><td>Chlorophyll, Silicic acid, Pectin, Phenols, etc.</td><td>Mainly to prevent the plant pest (bacteria, fungi, insect)</td></tr>
<tr><td>Roasted Bamboo</td><td>Bamboo charcoal</td><td>As a farmland improvement material</td></tr>
</table></td><td>・ Crash the roasted Bamboo, and use as a compost material. It can increase effective microbe's population in compost.</td></tr>
</table>

Step	*Process*	*Description*	*Remarks*
5		***<u>Application of Liquid I;</u>*** • *For health of plant, dilutes 1 ml of Liquid I with 5 l of water, and spray it on plants.* • *To enhance effects of Liquid II, dilute 30 ml of Liquid I with 1 l of Liquid II, and spray it on plants.*	• *For your health 1 ml of Liquid I dilutes with 500 ml of water, drink a little by a little everyday.* • *This gives good effects to cell activities.*
6		***<u>Application of Liquid II;</u>*** • *To prevent plant pest, 1 ml of Liquid II dilutes with 300-400 ml of water, spray to plants.* • *To enhance effects of the other natural pesticide, 1 ml of Liquid dilutes with 400-500 ml of natural pesticide, spray on plants.*	• *In Japan, this is a popular material for organic agriculture and daily health care. It shows sterilizing power.*

16. Improved Grain Storage

Step	*Materials to be collected*
0	***Background:*** *In recent years, maize loss in the post-harvest period has become very serious problem in Malawi. The damage is induced by Larger Grain Borer (LGB), a species introduced from Central America about 10 years ago. In 2001/2002, the loss in the post harvesting period was reported at about 17%, 176,000 tons, which is enough to feed more than 800,000 people for a whole year. Since this insect can eat woody materials, traditional grain storage made of bamboo cannot prevent the insect. Therefore, an appropriate post-harvest technology that is an improved grain storage is introduced.*

Collect all the following materials for a standard grain storage of 130 cm x 85 cm = 10 bags capacity

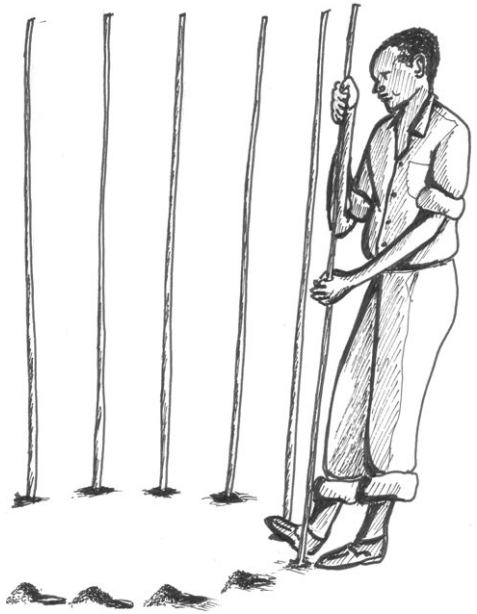
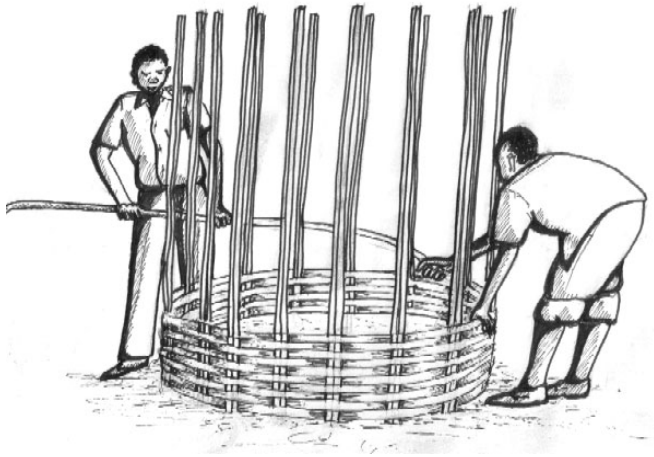
- *Four Y-shaped strong support posts, 100cm long and 15cm diameter,*
- *Two horizontal platform support beams, 50cm longer than beam diameter (= 180 cm)*
- *A number of straight floor poles, 6- 7 cm diameter, and 20cm longer than the bin diameter (= 150 cm).*
- *Sufficient number of recently cut twigs 1 – 2 cm diameter.*
- *Clay soil for plastering preferably less cracky type.*
- *Fiber for tying*

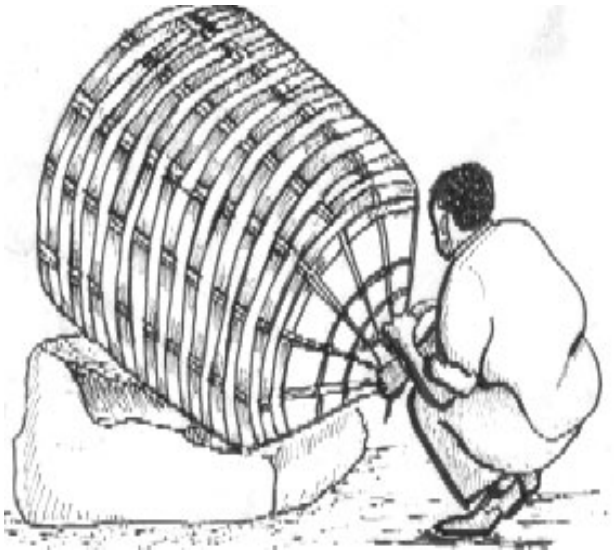
Approximate Capacities and Sizes

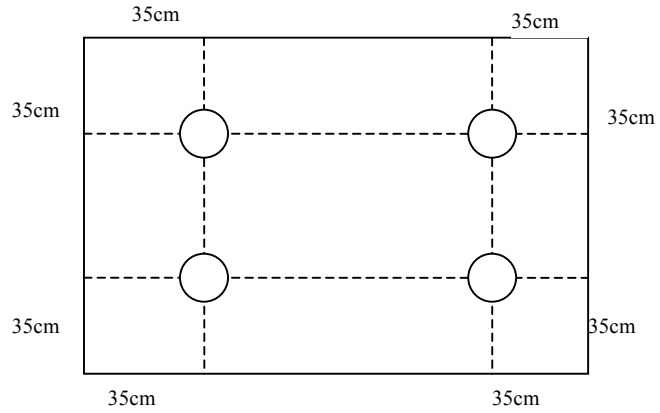
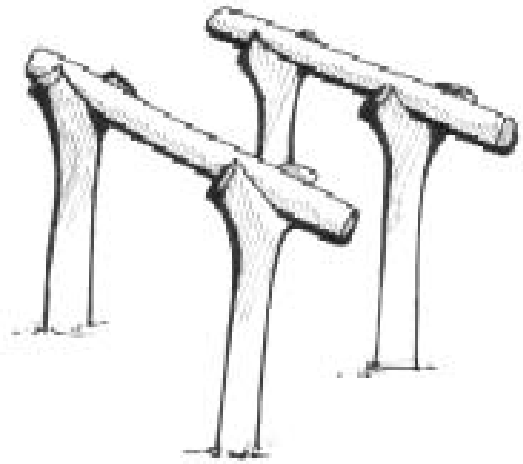
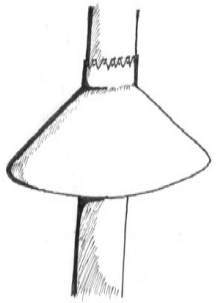
Height (cm)	*Diameter (cm)*	*Capacity (90kg-Bag)*
100	*100*	*7*
75	*130*	*9*
110	*110*	*9*
85	*130*	*10*
75	*140*	*11*
85	*140*	*12*
120	*120*	*12*
95	*140*	*13*
100	*140*	*14*
130	*130*	*15*

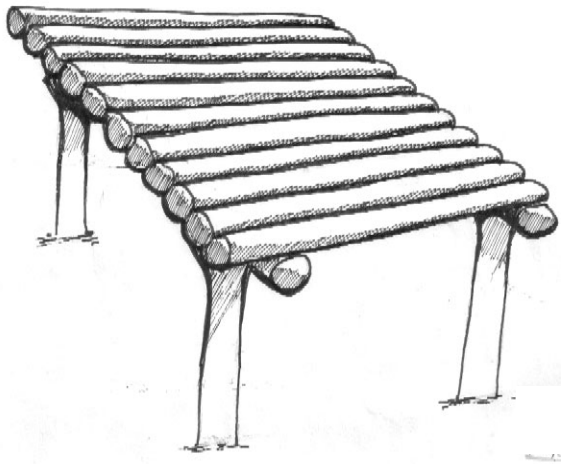
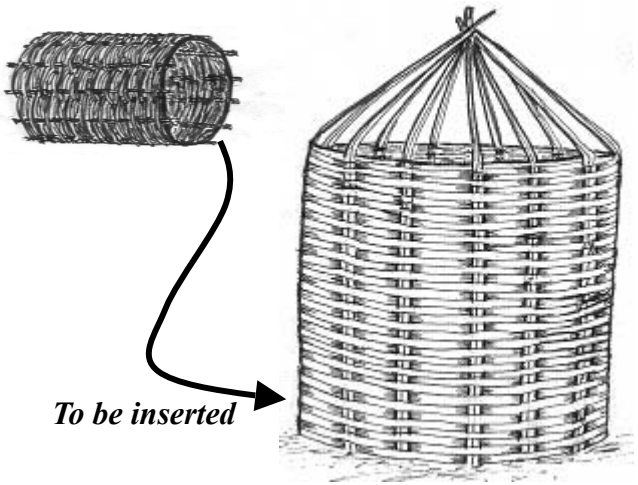
In addition to the improved grain storage, following are very important for post-harvest improvement:

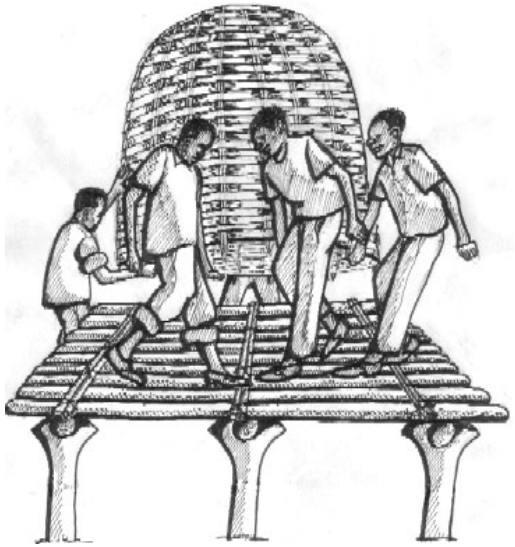
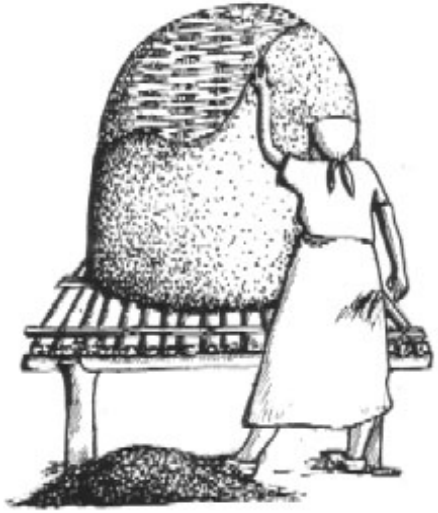
1) *Shelling before storing maize to remove harmful insects hiding in the pods away, and*
2) *Harvesting in the proper period and drying-up the product before storing to reduce rotten damages from humidity.*

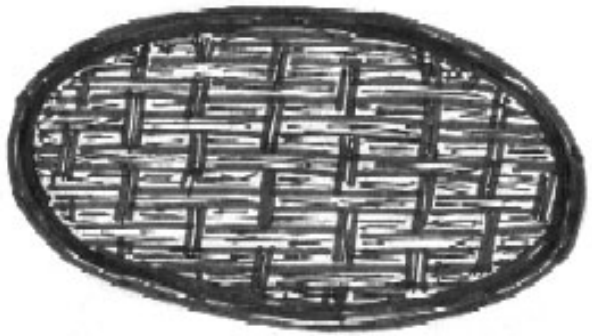
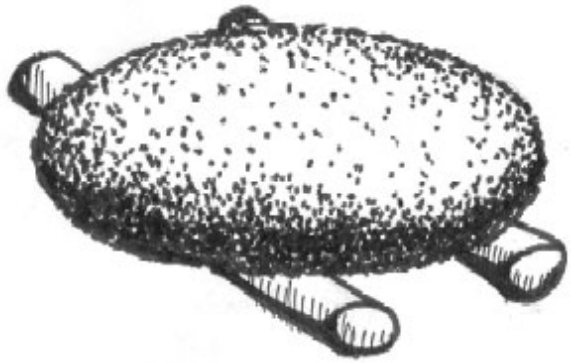
Step	*Process*	*Description*	*Remarks*
1		***Site preparation;*** *1) Remove the top soil to a depth of 5 – 10 cm.* *2) Draw a circle with the required diameter on the ground (130 cm in the example).* *3) Put a peg at the center as reference point.* *4) Mark equal stations 20 cm apart on the circle. Make uneven number of positions by either increasing or reducing the measurements. Dig small holes along the circumference, 4 – 5 cm wide and 15 cm deep.*	*Select a site where there is no water problem.*
2-1		***Weaving;*** *1) Place one (1) stick vertically in each hole. The length of the sticks should be a little more than the total height of the completed basket. Compact the soil around the sticks so that they remain firm during weaving.* *2) The horizontal sticks are pressed as the weaving progresses so that there is hardly any space between the layers.*	

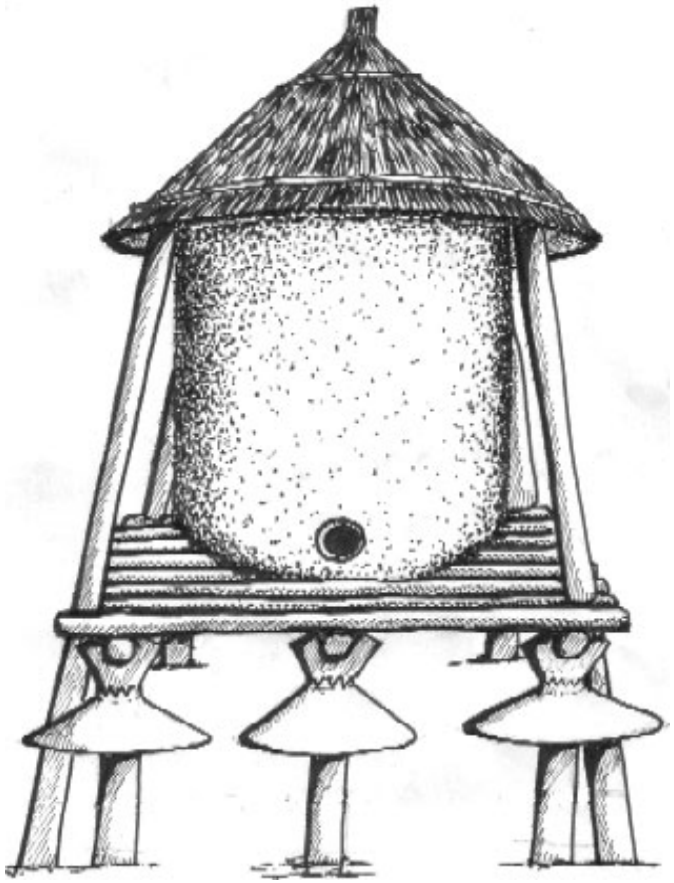
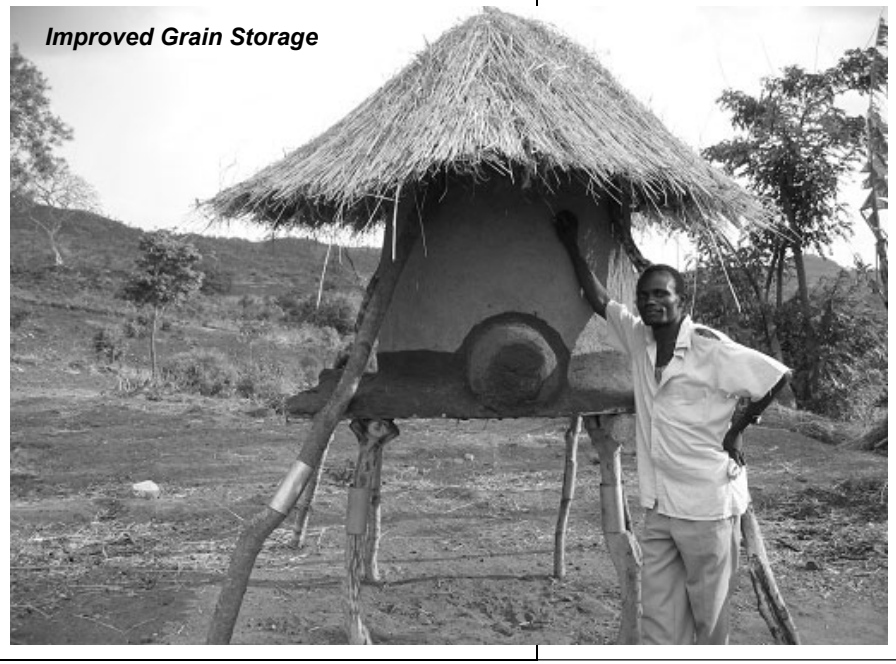
Step	Process	Description	Remarks
2-2		3) *Bend the vertical sticks when you reach a height of the basket (85cm height in the example) and tie them together. Take care not to break the sticks. Make sure that the sticks are in line with the center peg.* 4) *The weaving is continued until the opening (manhole) is 50 cm wide. The thinnest twigs are used near the manhole of ease of weaving.*	*If the weaving becomes too difficult near the manhole cut all the remaining vertical sticks just below the tying. This should be done when the basket is almost completed, so that the vertical sticks remain as if they were still tied together.*
3		***<u>Preparing the manhole;</u>*** 1) *When the size of the manhole is reached at 50 cm-diameters, lift the basket from the ground. Tie the last 3-4 layers of the horizontal twigs all round with fiber to hold them together. Cut the protruding vertical sticks just above the last layer.* 2) *Also cut the protruding horizontal twigs inside and outside the basket in readiness for plastering. Tie the first 3 – 4 layers of the horizontal twig at the bottom of the basket. Cut the protruding vertical sticks to a length of 2-3 cm beyond the first layer.*	*A 22 cm opening should be made at this stage at 3 cm above the first horizontal twig at the bottom of the basket for the outlet.*

Step	Process	Description	Remarks
4-1		***Making the wooden platform;*** *1) Place a book on the ground where the platform is to be constructed and trace the first right angle following the edge of the book.* *2) Extend the lines and mark the required measurements of the platform (180 x 150 cm in the example).* *3) Mark the positions for the Y – shaped posts by measuring 35 cm from each corner at the intersection of the dotted lines as shown in the figure.*	*The long and short sides are 50 and 20 more than the basket diameter. The platform should be rectangular and bigger than the basket to allow a person to stand on when filling the bin.*
4-2		*4) The holes for the Y – shaped posts are dug at the junction of the four dotted lines inside the rectangle. These holes should be 60 cm deep and 20 – 30 cm wide.* *5) Place the four Y-shaped support posts in the dug holes.* *6) Fill the soil treated with wood preservative, (creosol), wood ash or used engine oil to protect the posts from termite attack.*	*If you have iron sheet, put it at 50-60cm height on each post same as the figure to prevent rats from entering.* 

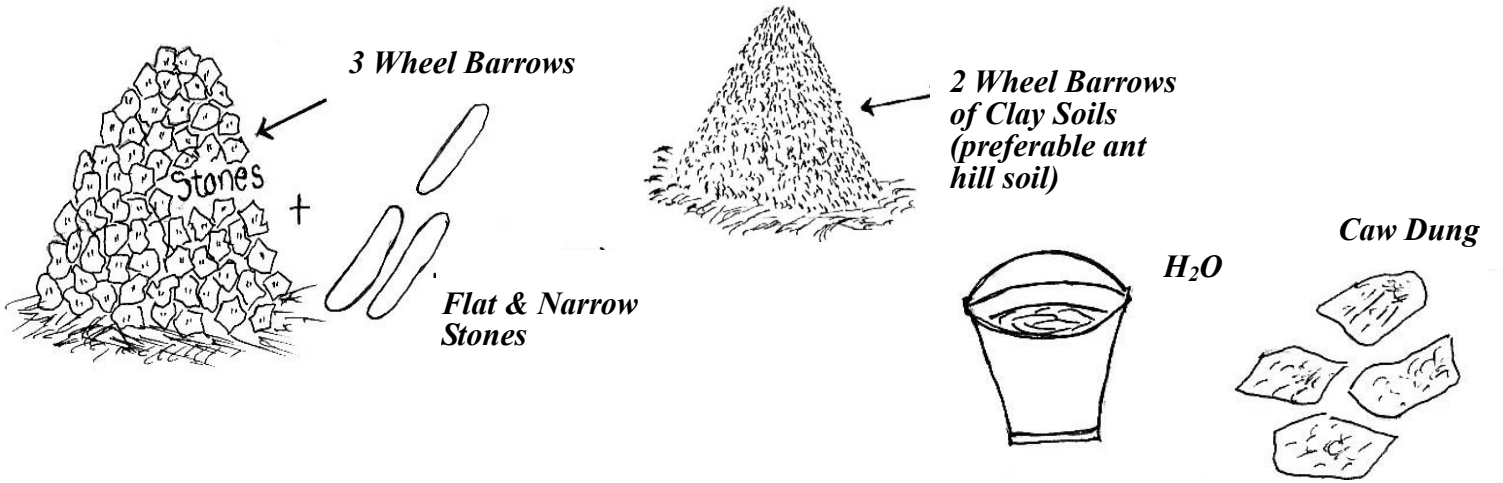
Step	*Process*	*Description*	*Remarks*
4-3		*7) Place the two beams onto the Y-shaped posts.* *8) Then, place the floor poles on top of the beams and tie them to the beams using fiber and horizontal sticks.*	
5		***Making the outlet;*** *The procedure of making the outlet is same as weaving the basket of the storage body. Only difference is that this has a smaller diameter of about 15 cm with 40 cm high.*	

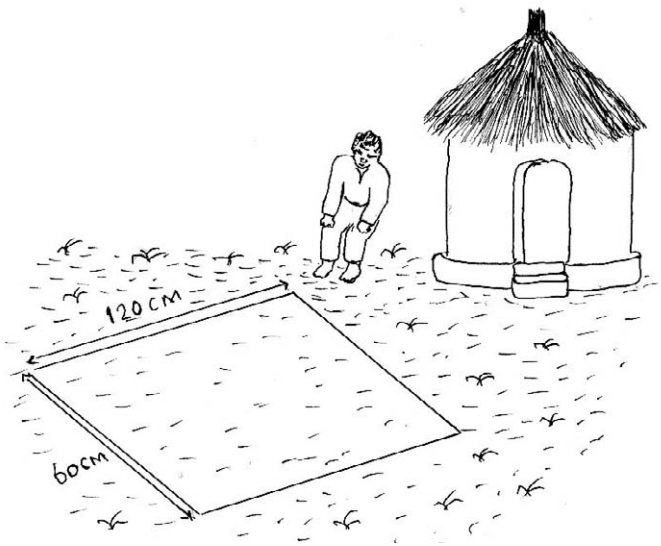
Step	*Process*	*Description*	*Remarks*
6		***Placing the basket;*** *1) Lift and place the basket on to of the platform. Make sure the basket is sitting squarely on the platform having room for standing.* *2) Fix the outlet onto the opening that was cut in the basket. Secure it by tying with wire or fiber.*	
7		***Plastering the basket;*** *1) Find suitable soil for plastering. It may be necessary to mix with copped grass to reduce cracking. Add water and mix to make a paste. Plaster both the external and internal walls including the floor as a rough-cast. Make sure that all the visible openings are closed. Let it dry for two days.* *2) After 2 days apply a thin coat of mud plaster on the wall and smoothen the surfaces (inside and outside).*	

Step	*Process*	*Description*	*Remarks*
8-1		***<u>Making the lid;</u>*** *1) Take a flexible twig and form a circle with diameter of 60cm. Place sticks across the circle, tying them closely to form a mat covering the ring.*	
8-2		*2) Plaster the topside of the lid with appropriate mud to cover the sticks. Leave it to dry for a day. When the first layer of the plaster dries, turn the frame and plaster the other side.* *3) Leave it to dry for another day. To finish off apply a thin layer, make smooth and leave to dry in the shed or while covered with sacks and grass.*	

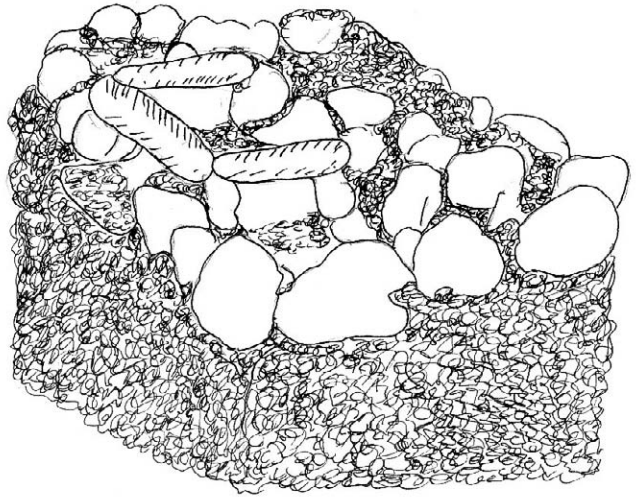
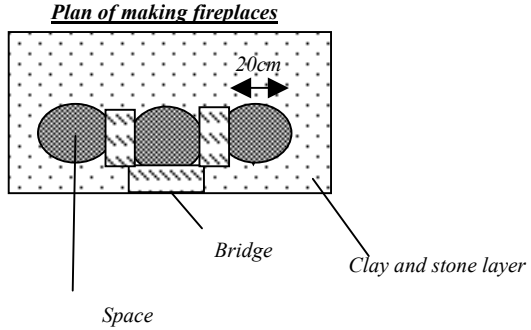
Step	Process	Description	Remarks
9		***Construction of the detached roof;*** *1) This is according to tradition. However, the support poles must be big enough and fixed firmly in the ground to withstand the dead load imposed by the roof, framing and forces of wind.* *2) Support poles must be positioned about 60 cm from the bin and equidistant from each other. The thatch roof must have sufficient over hang.* ***Improved Grain Storage*** 	*Some villagers so far tried brick made storage which is also useful. The problem is roof portion which is usually open straight to the sky. It is recommended to cap with plastic paper, so that LGB cannot enter.*

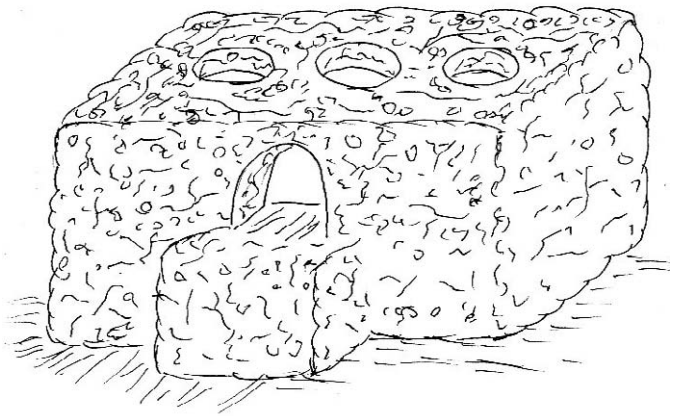
17. Construction of an Energy Saving Stove (Kamado)

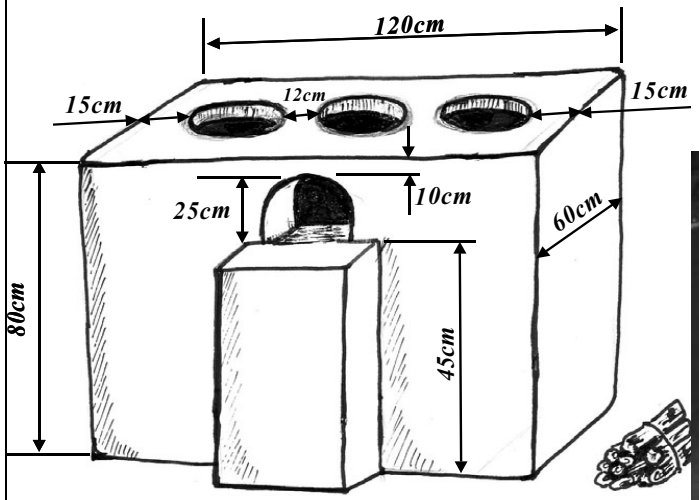
Step	*Materials to be collected*
0	***Collect all the following materials**;* ・ *Stones and rocks of 15 cm to as big as 30 cm in size: three wheel-barrows of volume* ・ *Three flat and narrow but long stones like our lower arm (these are used as bridges through which firewood is put and fire moves)* ・ *Clay soil (ant hill soil is better): two wheel-barrows of volume* ・ *Water: 5 – 10 buckets of volume* ・ *Cow dung: half a bucket of volume* *Above materials are all available locally. Nothing is needed from outside to construct the improved stove. If these masteries have been well prepared in advance of the construction work, it takes half a day only to complete the energy saving stove with several participants. The stove is very easy to construct and maintain, but it saves firewood at least by half and under well cared condition it can save by as much as three quarters of firewood. This contributes to conserving catchment area, which is the place of creating the water: the source of irrigation. As well, the stove will relieve rural women from the time consuming job: that is firewood fetching, and backache s because with this stove, they cook while they are standing upright..*
	

Step	*Process*	*Description*	*Remarks*
1		***Align the base;*** *Draw a square (above 120 cm x 60 cm) on the ground where the stove will be constructed.*	*The size, 120 x 60 cm, is just a standard of having three fire-places. If you need only two fireplaces, you can reduce the width of 120 cm to 90 cm.* *Likewise, if you are to place number of plate and cooking pans on the stove, you should increase the length of 60 cm to 90 cm.*
2		***Prepare mud;*** *Make clay heap and push the top to make it hollow, and put water together with cow dung in the hollow/space and then mix it.*	*Cow dung, a fiber rich material, is mixed to make mud stickier and strong. If cow dung is not available, no need to worry but just prepare good clay soil. No organic clay soil should be used as this does not provide good binding material.*

Step	*Process*	*Description*	*Remarks*
3		***<u>Make the base;</u>*** *Prepare mud base first and then put stone layer next. Build the base with these layers up to appropriate heights.*	*Put big strong rocks at the base because this will receive the whole mass of the structure and as such, they need to be strong. Avoid putting brittle stones at the base of the stove as they may crack due to the self-weight of the stove.*
4		*<u>Refer to the Illustration</u>* *Repeating the procedures of alternating mud layer and stone layer up to 45 – 50 cm.*	

Step	Process	Description	Remarks
5		***Make a shelf for supporting firewood;*** *Make a shelf to place firewood by using wide and thin stone. Or, make a pillar attached to the base up to the level of placing firewood.* *Put thin stones on the level where firewood would be placed and make it level. Then cover the surface with clay soil and make it smooth.*	*As we are building, we should check the verticality of stove. if the structure is not going vertical that is, upwards, the stove can easily collapse on the side which it has leaned.*
6		***Make fire place;*** *Make a small stone bridge on the shelf as an entrance for firewood. Then, make 2 bridges from the edge of the entrance perpendicular to the entrance.* 	*The stones for the three bridges should be carefully selected and their shape should be flat and thin but long. Otherwise if the shape of these stones does not match the standard mentioned above, fire holes are reduced and this makes it difficult to put firewood and again fire has difficulty in moving to side cooking places.*

Step	Process	Description	Remarks
7		***<u>Accumulate stones with mud;</u>*** *Accumulate stone and clay layers up to top of the bridge except 3-fireplace areas. Then, Smoothen the surface with mud.*	*Keep a distance of at least 90 cm from the ceiling to avoid fire reaching the ceiling of the house. This is only true if you are to install the stove in a house.*
8		***<u>Waite for a week before using;</u>*** *Wait for a week or so until the stove gets dried. Cracks that may appear during the curing should be smeared with mud mixed with cow dung.*	*The stove requires regular maintenance, especially rim of the fireplaces, otherwise it starts cracking and falling down.* *Maintenance is done by smearing the stove with soil mixed with cow dung. Once a week maintenance is good enough for keeping the stove in good condition.*

Step	Example	Remarks
	 Small Sized Stove (2 cooking places)  	***Advantages*** 1. *Materials are locally available.* 2. *It can save a considerable amount of firewood (about two thirds are saved).* 3. *Water can be boiled since there are extra fireplaces.* 4. *It can save cooking time as there are three fireplaces and create extra time.* 5. *Food can be kept clean since cooking place is high.* 6. *It can keep children away from fire.* 7. *It can ease back pain since one can stand while preparing food.* ***Disadvantages*** 1. *It cannot warm the house since fireplace is not open.* 2. *It cannot be moved to other place.* 3. *It requires more space.* 4. *It requires maintenance.*

Reference

This Technical Manual was prepared based on PD method developed in IFIC, JICA. The word of "PD method" comes from "Process Description method". This is a JICA technology transfer method of producing both an operation manual and (audio) visual aids using photos or illustrations, which are portrayed by superposing on the photos, of a series of actual activities of a work. The process description is made by: 1) taking a series of photos of a work, and 2) describing the activities in the photos by step mostly by counterpart personnel, through which the counterpart will acquire the skill and knowledge necessary for the work and also the manual is produced simultaneously. Hideyuki KANAMORI (1994): Effective Technology Transfer by PD Method (in Japanese), Journal of the Japanese Society of Irrigation, Drainage and Reclamation Engineering, Vol.62, No.12, pp.7-12

Inclined Wall Type Weir:

Seen at Mgunda site, Msanja village, Chiwanba EPA, Lilongwe District in May 2003. Invented by the villagers themselves.

Vertical Wall Type Weir and Double Lines Weir:

Hinted by a temporally water diversion/ stoppage structure such as sheet pile adopted in many construction sites which need dry work.

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