SUSTAINABLE ORGANIC AGRICULTURE AS A TECHNIQUE FOR RURAL COMMUNITY IN DEVELOPMENT (RUCID)

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INTRODUCTION

Defining sustainable Organic Agriculture.
To define the term 'sustainable organic agriculture,' it is important for us to appreciate the constituent terms in question.
'Sustainable' implies the satisfying of the changing human needs in time from generation to generation and within a generation. It means continuity in agricultural production that is equally distributed from generation to generation and within a generation. It is by definition correlated to sustainable development, which emphasizes development to meet the intermittent needs of present and future generations

'*Organic*' in relation to farming means a farming system that is essentially based on organic natural inputs from the farm and where inorganic agro-chemicals are only used where necessity allows.

The organic farm is made up of 'organs'. The farm may be likened to an organism[1]. The organs of an organic farm may as such include:
i) Land
ii) Animals
iii) People
iv) Diversity of machinery
v) Structures like houses and animal shelters
vi) Infrastructure like roads to market

[1] An organism maybe defined as a set of organs that simultaneously work together to perform a function

'Agriculture' refers to the growing of crops and rearing of animals on a farm this is in its broad sense. In Uganda, appreciably more than half of the active population is either directly or indirectly employed in agriculture.

Sustainable Organic Agriculture **(S.O.A)** therefore refers to that form of improved growing of crops and rearing of animals from generation to generation and within a generation; using natural materials from the farm and less of inorganic agro-chemicals.

S.O.A comes about as a result of a growing realization by farmers and consumers of farm products of the detriments associated with the use of inorganic agro-chemicals. To the farmer these chemical can be likened to a drug addict, without them (drugs) the farm can't sustain production at the conducive levels. To the consumer these chemicals are bio-accumulating such that with repetitive use these harmful chemical accumulate in the fatty tissue leading to such effects as; premature deliveries in expectant mothers, stunted growth of infants, mental retardation among others.

S.O.A includes the following specific measure that ensure that production on the farm is sustainable both in the intra-generational and intergenerational dimension:
a) Soil and water conservation
b) Organic manuring
c) Energy conservation and energy-saving stoves
d) Plant propagation methods
e) Vegetable growing and utilization
f) Natural crop protection methods
g) Post harvest handling of food

1.0 SOIL AND WATER CONSERVATION

Conservation refers to the wise management of the human use of the biosphere such that it can yield the greatest sustainable benefit to the present generation without compromising the ability of future generations to satisfy their own needs. Soil and water conservation thence implies the conservation of soil and water resources for the present as well as future generation so that equity prevails within and between generations. Specifically soil and water conservation refers to the combating soil degradation through conservation of soil moisture on the farm such that soil productivity can be sustained.

Soil degradation

It's a diminutive term referring to the total gradual loss in the appropriate chemical, biological and physical properties of soil leading to a reduction in soil productivity.
Forms of soil degradation include; alkalization, salinization, acidification and soil erosion among others. In Uganda however, over 90% of soils are degraded by soil erosion and this will be considered in detail below.

Soil erosion

It refers to the transfer of the topsoil by forces of denudation mainly wind and water (coupled with gravity) depending on the erodability of soil and the erosivity of the denudation eroding force. This gradually leads to a drop in soil fertility and consequent the productivity of soil dwindles

There are four main forms of soil erosion, which include;

Splash erosion: this is caused by the hitting of rain droplets on the ground (soil) leading to loosening of the topsoil yet compacting the substrata of soil. This decreases the ability of water to infiltrate the soil thereby eroding the loosened topsoil.

Sheet erosion; with the less water infiltrating into the soil, the top soil layer is evenly eroded along the whole breadth and length of the slope.

Rill erosion; with increase in the volume of water running down slope due to gravitational pull, the water begins to form small channels called rills.

Galley erosion; this is the most extreme form of soil erosion. It occurs when there is an enormous amount of water running down the slope and due to the now increased erosivity of the running water, it cuts into the ground to form deep gorge like impressions called *galleys*.

The rate and intensity of soil erosion is affected by the soil cover (vegetation), gradient of the slope, length of the slope, method of cultivation among others as shown in the table below;

TABLE SHOWING SOME LEADING CAUSES OF SOIL EROSION

PHYSICAL CAUSES	HUMAN CAUSES
Gradient of the slope	Overstocking/overgrazing
Slope length	Bush burning
Relief/topography	Deforestation/devegetation
Natural vegetation	Monocropping
Soil type/characteristics; sandy soils are more prone to erosion than clay soils	Indiscriminate tillage; tilling when it's not necessary
	Poor soil breaking methods
	Poverty; leading to over reliance on natural resources like soil and forests
	Lack of awareness
	Poor land tenure; like communal tenure
	Insecurity; growing annual crops
	Development; leading to creation of impermeable surfaces like road& pavements

These main causes of soil erosion lead to a couple of detriments in the areas where the soil is carried away (on-site) and where the eroded materials are deposited. These could be both positive and negative impacts, however, in general these effects include;

TABLE SHOWING THE EFFECTS OF SOIL EROSION

Loss of soil fertility	Fluctuation of water in rivers and other water reservoirs
Low productivity	Flooding
Famine	Transformation of vegetation due to change in soil depth
Malnutrition	Spread of human and crop diseases
Loss of income/poverty	Siltation of springs, rivers, wells and others
Family conflicts	Others…

However, soil erosion as a form of soil degradation can be combated by number of measures that may include; changing the gradient and length of the slope, protection of the soil from direct sunlight and rainfall as well as changing the soil properties to allow for more water infiltration.

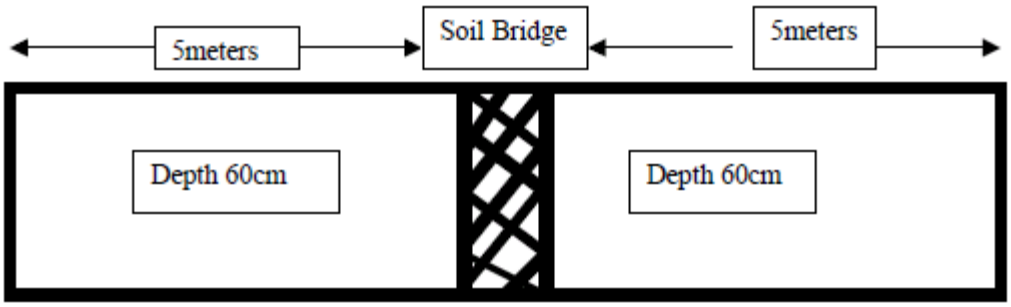
The solutions to soil erosion will be found to be centered on soil conservation through a number of agro-forestry technologies. The soil conservation here implies; using the land as it should be used using both soil enrichment methods (composting, manure, fallowing, ploughing back, and green manure among others) as well as soil protection methods (terracing, contour ploughing, rotational woodlots, hedge rows, among others). Better results are realized when the two methods are combined.

It must be acknowledged that the type of management option adopted will depend more on that particular farmer's interest, than on the management options available; their feasibility or their affordability. A farmer whose interest is to increase soil production may adopt rotational woodlots as a management option leaving probably a more affordable and feasible option of hedgerows.

Even still each farmland is faced with a unique set land management challenges, some are faced with poor soil fertility, while others with poor drainage. The technologies hence discussed below are biased towards a farmer's interest/goal/challenge. They, however, are ebbed on checking the erosivity of water.

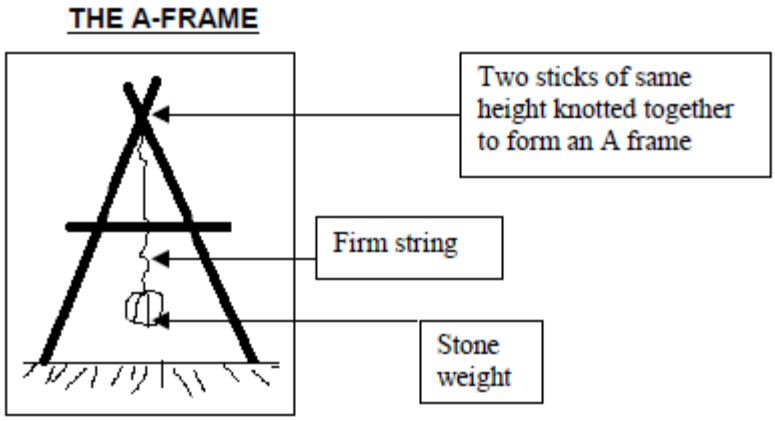
Cutoff drain

To control erosion by water on a given farmland start by determining the number of plans on that farmland and then proceed first by controlling water from external catchments (upper plane). This is the purpose of the cutoff drain.



The cut off drain design can be improved by planting grass on the embankments to filter the silt from the running water. This maintains the shape and depth of the cutoff drain. For more effectiveness, there is need to provide a contour drain about five meters down slope from the cutoff drain.

The contour drain is designed using an A-frame or a water level design. Each of these two apparatus will demarcate the areas of he same height above sea level (contours) in which water will meander if a channel is dug along those lines.



Depth 60cm Depth 60cm

5 meters
Soil Bridge
Firm string
Stone weight
Two sticks of same height knotted together to form an A frame

2.0 ORGANIC MANURING METHODS

A plant's vegetative growth is a reflection of the available nutrients (fertility) of the soil. The plant is made up of elements that are in the soil. When there are few nutrients in the soil, the plant will be stunted and vice versa.

Defining Soil

Soil is an organism, that's it is a collection of organs that perform a function including solids, air, water, micro and macro soil organisms. Thence whenever a plant is harvested and the residue not returned to the soil, the minerals in the soil are lost and this leads to less abundant successive growth and a drop in income earned from agriculture. Soil fertility is thence many times analyzed by the availability of vegetative growth upon the soil. To combat loss in soil fertility, many a rich farmer opt for the rather "quick result" inorganic agro-chemicals. However these are accredited to a number of detriments; they reduce the numbers and variety of soil microbes, reduce the structure of the soil to dusty soils, and reduce the moisture-holding capacity of the soil among others. The solution to all these shortcomings thence lie in the adoption of sustainable organic manuring techniques. These depend on the energy available, materials available and land available. Examples of such methods are discussed below:

Green manuring

Here the farmer grows crops, preferably leguminous plants and at flowering stage he/she digs the crops while mixing it with the topsoil. This practice revitalizes the soil fertility leading to an increase in soil productivity and income earned.

Liquid manure:

This is obtained by use of a container filled with water, then some wood ash and animal waste are put in a permeable sack and dropped into the container. This combination is left for about two weeks and later the liquid is applied into the field especially to delicate crops like vegetables. A similar form of manure is plant tea; where fresh leaves that can easily decompose like *Tithonia* are put in water for about 7days they the liquid is poured on vegetables and other crops

Composting:

It refers to the process of breaking down the organic material into its constituent elements. In composting there's need for materials that decompose fast. Including weeds, grasses, animal wastes among others. There's also need for decomposition bacteria and optimum water availability.

The site of decomposition should be in a shade area to prevent evaporation of water or other volatile nutrients. In dry areas a pit (preferably 90 X 120-180cm) is dug to conserve water yet in humid areas, the organic material is merely mound under a shade. The land below the decomposing material should be broken to allow for water percolation. The compost is made up of layers of sticks and twigs or maize stocks; fresh grass; sprinkled ash, poultry waste, a thin layer of wood ash, another layer of animal droppings (6-10cm per layer), layer of fresh soil, then some water is added. Finally a thermometer stick is pushed into the mound to measure the temperature. Cover the heap with banana leaves to prevent excessive evaporation.
The compost heap will last about 2-3 months to form the compost manure. To apply the compost to the plant; put a spade of compost into the plant hole before seeds are lanted. For bananas, sprinkle the compost 2-3ft away and around the plant.

3.0 ENERGY CONSERVATION AND ENERGY SAVING STOVES:

There is an energy crisis in Africa. Rural farmers spend a lot of valuable time searching for fuel wood especially in the wet season when they could be doing more important agricultural roles like planting and preparation of gardens. Besides in a bid to cut on the energy spent in searching for fuel wood farmers opt for the less tenuous option of deforestation. Energy conservation thence comes at a time to try and correct this discrepancy by ensuring that the farmers shall use less fuel so that it can last them longer than otherwise, more importantly in the wet season, thereby reducing deforestation and the risks associated with it.

The major forms of energy include; solar energy, fuel wood (more important), electricity, geothermal energy, biogas, animal waste, petroleum products, agricultural waste. Of these mentioned 96% of the energy used in Uganda is fuel wood, 1.4% petroleum products, electricity, 0.5%.

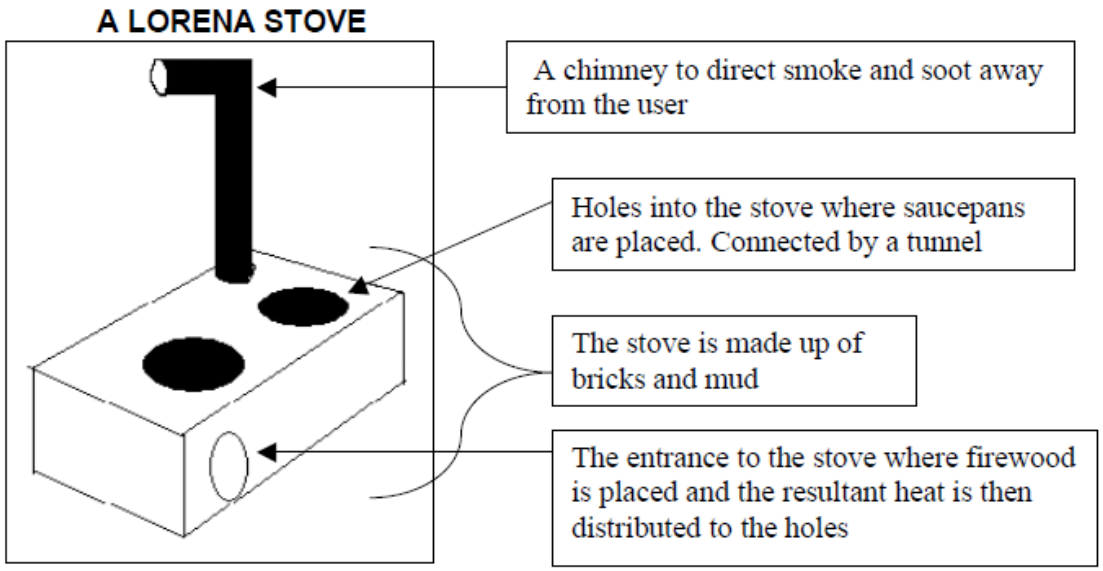
There are many indictor of a fuel crisis, which may include; an increase in fuel prices; some rural people now pay for fuel wood yet previously it was a free commodity; use of agricultural products like maize stalks, serious encroachment on forests; emergency of projects like Join Energy and Environmental Program (JEEP).

The response to such crises has been through; establishment of private woodlots, aforestation by government (like Masaka Tree Planting Project) use of alternative energy sources, awareness campaigns and the use of energy saving stoves, and use of simple kitchen energy management (including; cooking food in covered pans, cut small pieces of food, use dry wood in small pieces among others) However, the use of energy saving stoves can't be emphasized enough. It is cheap, reliable and requires a small shift from the normal agricultural and energy utilization techniques used in rural areas.

There are many forms of energy saving stoves, which may include:

A fireless cooker; here the food is preheated to boiling point and a stone is heated in the meantime. The stone is then removed and placed in sand inside a basket. The food is placed on the stone inside a basket and then covered. The basket acts as an insulation to conserve the heat from the stone in the sand.

Lorena stove; this stove was designed to overcome most of the shortcomings of a normal three stone stove. It provides a better environment than the three stone stove (less smoke), is more fuel efficient, longer lasting and the materials used are locally available and cheap, including: clay soil or ant-hill soil, Lake sand, water, sweet potato vines and a banana stem. The tools used include: hoes, basins knife, panga, spade and saucepans of different sizes. It's made by first destroying all the clods in the clay which is then added to sand and mixed well. Water is then added gradually in the mixture and mudded until it is 'ready'. The made is then molded into balls. Mark out the size of the stove you want in your kitchen and place banana stems to act as frames together with bricks. Then fix mud to build a stove. Remove the banana stem and then construct a chimney.



Other forms of energy saving stoves include mandeless stove, improved charcoal stoves among others.

4.0 PLANT PROPAGATION

Plant propagation means to increase plant numbers by natural means from a parent stock. There are many accepted ways to practice plant propagation including grafting and budding.

Grafting:

This is where a farmer uses a sharp razor; pencil-size seedlings of a local variety. With the razor cut a pencil size off a desired variety (exotic or a better local) the part should be cut just before flowering, to fasten propagation of the seedling. Join it to the already cut local seedling using a polythene strap. The joint could be slanting or V-shaped. You may wrap polythene around the leaf part of the plant or remove most of the leaves to prevent excessive evaporation and avoid contamination of the joint.

Budding:

Here the farmer collects bud(s) from a desired species and fixes this to a removed bud from a local seeding. The advantage here is that the farmer is able to have many varieties of a particular crop say, a mango on the same plant, as each bud develops into a different branch of the same tree unlike grafting.

5.0 VEGETABLE GROWING/UTILIZATION

Vegetables are part of the balanced diet that a normal healthy person needs to have everyday in order to remain health. They are the main source of vitamins and minerals for proper human growth and development. Types of vegetables include;

1.) ***Brascas*** (including cabbages, *sukumawiki*, lattice and any cabbage-like edible plant) they supply vitamin K (for blood clotting) and E (for fertility)

2.) ***Solanacy***; these contain more minerals; they grow with a 'button' on top including; tomatoes, *nakati,* bitter berries *(ntula),* egg plant and pepper.

3.) ***Cucabits***; these too contain a lot of minerals. They include cucumber, pumpkins, *nsusuti,* watermelon and any cucumber-like edible plant.

4.) ***Allies*** (these are spices and curative) they includes all onion types; onions, garlic and leeks

5.) ***Amarantha;*** (they have more iron and vitamin K and iodine.) including red and green *dodo*, *bugga, mboge*

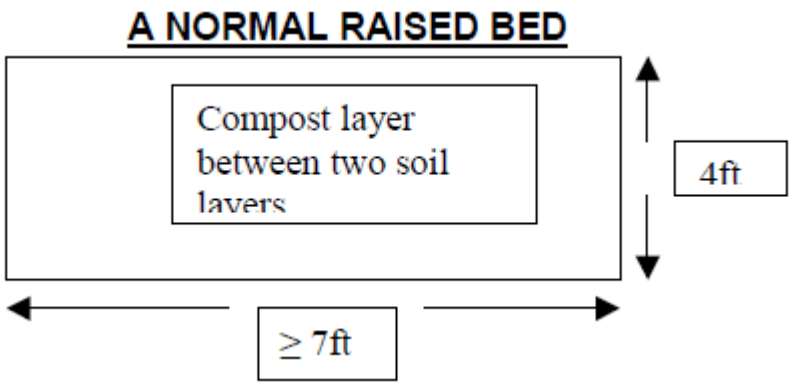
6.) ***Legumes;*** including: beans, Soya, pigeon peas, cow peas among others

How to make vegetable beds:

There are various types of vegetable beds and they include the following;

a) ***Normal raised beds;*** these are made where the soils are deep and soft. They are made by mounding a layer of soil upon which a layer of compost is laid. Then a final layer is mound on top of the compost layer. The vegetables are then planted after two weeks in rows and columns on the normal raised bed.

A NORMAL RAISED BED



Other forms of vegetable gardens include; sunken beds (conserve rain water), mound beds (good in compounds) pole gardens (vegetables grow in tins hang on a tree) normal flat beds (commercial) and the double dug beds (used in compact soil solum).

b) ***Sack garden;*** this sort of garden is very effective in areas with less space for proper gardening. The garden is made using a sack, stones and compost mixed with soil as shown below;

Vegetable preparation:

- Vegetables should be grown near to homesteads to easy harvest and preparation because every day they spend after harvest without being prepared, they lose some vital vitamins like cabbages lose vitamin K under such circumstances.

- Vegetables should be washed and sliced before consumption because they contain a lot of parasites that may threaten human health. (Carrots should be warmed before consumption because they don't easily release their minerals and vitamins, cabbages shouldn't be cooked at all, if they are however, 10 minutes will do they lose vitamin K by evaporation)

Points to note in vegetable growing and utilization:

- All types of vegetables under a given family contain similar food values. For one to derive full nourishment there's need to depend on many vegetable families
- The different families of vegetable derive different nutrients from the soil; thence there is a need to practice crop rotation (this controls pests too)
- Vegetables have special requirements; they require deep and richer soils

6.0 NATURAL PLANT PROTECTION METHODS

A pest is an organism that hinders proper growth of a crop or animal leading to a reduction in production. Today emphasis has been withdrawn from use of *Integrated Pest Management* (IPM) because it provides for use of chemical pest control methods in case local cultural methods fail. The quality of chemical used should have one or more of the following characteristics; irritation, corrosion, poisonous, suffocation, repulsion and attraction. Sometimes there are local chemicals used in IPM including; pepper, phytolaca, tobacco, tithonia, neem tree, tephrosia, papaw leaves, merigold among others

Types of Pests

1) Virus
2) Bacteria
3) Animals
4) Plants
5) Nematodes
6) Insects
7) Fungi

Problems Associated With Use of Agro-Chemicals in pest control

- Some are non-selective and kill even beneficial organisms like some may kill pollinating insects. For instance use of such chemical led a decline in sorghum production in Tororo due to a decrease in bee numbers
- They contain a lot of impurities that lead to bio-accumulation along the food chain
- They lead to a local farmer's over-reliance on the pesticide produce. Such that without them production dwindles considerably.
- With successive use, resistant populations of pests develop
- There is loss of soil structure finally turning to dusty soils
- Require complicated methods of application including; protective wear, specific weather conditions, literacy requirement (for labels), labels in strange languages, among others The solution to the use of such harmful chemicals thence lies in the adoption of ecological cultural methods that not only enhance soil and environmental values but also are cheap and require a little shift from the normal cultural farming methods.

Ecological Pest Management Techniques

Direct control methods;

1.) **Quarantine;** this involves isolation of infected crop or animal from the farm

2.) **Biological control*;*** this involves use of a natural enemy of a pest to control its population for instance a lady bird on a farm will control the population of aphids on a tomato garden, others include; wasp Vs caterpillar larva, spiders Vs flying insect pests among others.

Indirect control methods;

These include a change in the farming technologies so as to interfere with a pest's life cycle. They include the following:

1.) Mixed cropping*;* this includes growing of more than one crop on the same piece of land for instance interplanting of simsim with cassava to control Morrow rats. The simsim has very bitter roots that ward off the rats. Agroforestry technologies also lie in this category for this case the various trees on a farm interfere with adours from the host plant thence making it hard for the pest to locate the plant.

2.) Hygiene methods*;* these involve ensuring that the gardens are kept clean and free from infected plants or rotting plants. For instance don't allow rotten mangoes to litter the vicinity of the mango tree. Another example is the control of maggots in bitter berries by ensuring that they are harvested while still green before the maggots mature (the maggots enter the berry at flowering stage and mature at ripening) also it's good practice in hygienic control of wastes to ensure that the garden is free of weeds and to check crop foliage regularly to remove infected crops before dispersion of harm.

3.) **Physical management*:*** this includes the following specific measures;

a) Hand picking
b) Scare crow
c) Trapping
d) Crop rotation
e) Double fencing
f) Ditches (control wild pigs)
g) Encourage pests' natural enemies
h) Increase soil fertility
i) Plant tolerant crop varieties
j) Mixed cropping
k) Early cropping
l) Right spacing

Benefits of ecological management of pests*:*

1) They are inexpensive
2) Increases crop production (mixed cropping)
3) Doesn't lead to new cultures
4) Good for environmental conservation
5) Selective
6) No bio-accumulation

However, use of such methods in pest control has **disadvantages/limitations** too which may include: they are hard to use on large scale, take long to react to pest population, require knowledge on the lifecycle of pests, and are labor intensive.

7.0 POST HARVEST HANDLING OF FOOD (FOOD PROCESSING)

This refers to how what to do to food from the garden to the dining table. This concern has risen out of the fact that 35-40% of the food produced on the farm is lost before and after reaching the dining table (NARO 1998).

A post harvest pipeline shows how the food is wasted from the farm to the dining table. However, such a discrepancy can be overcome by many solutions, including: government intervention *(Plan for Modernization of Agriculture)*, improvement of transport facilitities, construction of silos granaries and cribs, awareness campaigns on food handling, among others.

To the contrary, one of the most formidable solutions to post harvest food loss lies in food processing at household level, regional and national level. Besides addressing post harvest food losses, there are many reasons for food processing including; it adds value, extends the shelf life of various food products and addresses the global demand for tropical organic foods, poverty alleviation among others. Below is an illustration of food processing procedure;

PROCESS FLOW CHART FOR JUICE MAKING

1. Select the farmers to supply you with the fruits (environmental consideration: are farmers well groomed to produce organically?)
2. Sorting: The ripe ones should be separated from the unripe and the damaged ones.
3. Weighing;
4. Recording; to estimate the volume to be produced
5. Washing, Peeling, Slicing And Extracting Juice
6. Formulation; how much juice extracted? How much sugar or preservative to add?
7. Filtration/sieving
8. Pasteurization (870-930C)
9. Bottling and labeling, recording
10. Distributing and selling

Food processing activities also face a number of challenges for instance: the unfavorable tax policy including the fact that local 'starters' are not given tax holidays. There's also lack of dissemination of researched information, prohibitive regulations and lack of networking between food processors and on the part of food processors, there are such offences such as mislabeling and deceptive labeling.

CONCLUSION

As individuals, farmers face many difficult choices; land conservation with its long term benefits has to be balanced against use of agrochemicals which tends to yield more immediate benefits. Daunting as the choices are for decision makers (Ministry of Agriculture, among others), let us bear in mind that in the meantime, choices are being made daily by these farmers with broad scale impacts albeit with limited understanding of all the factors involved; they are being made by the hundreds of farmers whose families are stricken with starvation and can not hold on to the long term benefits of organic agriculture, by those manufacturing agrochemical and many others that decide by force of circumstances. If implicit micro-choices are already being made they should by complemented by explicitly made macro-choices; by design rather than by default.