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A GUIDE TO
AFE BABALOLA UNIVERSITY, ADO EKITI FARM

(ABUAD FARM)

A GUIDE TO AFE BABALOLA UNIVERSITY FARM

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CHAPTER I: CROP PRODUCTION

AGRICULTURAL POTENTIALS OF NIGERIA AND THE CONTRIBUTION OF AFE BABALOLA FARMS TO FOOD SECURITY IN NIGERIA

Agriculture has huge potential to foster the economy of the nation with its various operational aspects for wealth creation, essential for poverty alleviation of individuals and national development. Agriculture is crucial to the sustenance of life and sustainable economic development to the renewable land resource as a major economic factor for agricultural production, leading to provision of nutritious food needed for human development and raw materials for industries. Agriculture is an essential fulcrum for propelling food security in the economy of serious minded governments throughout the world because it contributes greatly to the national Gross Domestic Product, creates employment, provides food and earns foreign exchange sustainably to nations. Nigerian agricultural resources can be classified into two; crop and animal. Are Afe Babalola, a successful legal luminary and a farmer, tapped into the vision and prosperity of the Nigerian agrarian society by producing vegetables (tomato, pepper,) grain (maize, rice, sorghum), legume (soyabean, groundnut), tubers (yam, cassava), tree crops (orange, mango, cashew) and oil seed (oil palm and moringa) recognizing the short fall in the food production of the dependent rural subsistent farmers for agricultural production in Nigeria. Fruits are natural staple food of man containing essential nutrients in adequate proportion. Fruits are excellent sources of minerals, vitamins and enzymes. They are easily digested and bring about a cleansing effect on the blood and the digestive tract. Hence, the ailments usually caused by the consumption of unnatural foods can easily be treated with fruits. Animal resources are divided into fishery, livestock (pig) and poultry (chicken and quails). There are also forestry resources such as, plantation (timber (i.e) melina and tick, ornamental (flowers). These soils used to grow the crops and biodiversity of these crops are potentially renewable resources which can be replenished fairly by nature, the management and development of this farm have led to training of Agbekoya farmers consisting adults and youth in Ekiti on arable farming and fisheries on improved farming practices and better income earning through agriculture. The timber resources offer a lot of wealth creation opportunities when converted to industrial raw materials for pulp and furniture.

MORINGA PRODUCTION

The Moringa Tree, *Moringa Deifere,* was probably been the most popular plant in ECHO'S seed bank of underutilized tropical crops. The tree is native to India but has been planted around the world and is naturalized in many locales. Moringa goes by different names. In the Philippines, where the leaves of the Moringa are cooked and fed to babies, it is called "Mother's best friend and "Malluriggay". Other names for it include the benzolive tree (Haiti) horse radish tree (Florida), Nebeday (Senegal) and drum stick tree (India).

There are about 13 species of Moringa tree in the family *Moringaceae*. They are native to India, the Red sea area and/or parts of Africa Including Madagascar. *Moringa oleifera* is the most widely known among other species. The term "Moringa" refers to *M. olajera*. All other species are referred to by their Latia name.

Cultivation

Moringa grows best in the hot, semiarid tropics. It is drought-tolerant and grows with rain falls of 250mm-1500mm per year. Altitudes below 600m are best for Moringa cultivation. However, it grows up to 1200m in some tropical areas and has been recorded growing at 200m. It is observed widely that excessive windy conditions cause the tree to dry out. A good temperature range for the tree is 25-35^{0}C (77-95^{0}F), although it can tolerate up to 48^{0}C for limited amounts of time. The Moringa tree prefers well-drained sandy or loam soil. It will tolerate a clay soil but not water logged. It tolerates a wide range of PH (5-9), growing quite in alkaline conditions up to a PH of 9^0. It responds well to much water and fertilizer.
Moringa is an extremely fast-graowing tree. It can reach up to 4m in a year, reaching an eventual height of 6m-15m (20ft – 50 ft). Roy Dan forth in Zarie wrote, "The tree grows word rapidly that papaya, with one three-month old tree reaching 2.4m (8ft). I never knew there would be such a tree." The tree in an organic garden grew to about 4m in 9 months, and had been out back several times to make it branch out more. It is advisable to prune trees frequently to a shrub form, or they will become lanky and difficult to harvest. If folks begin regularly breaking off tender tips to cook when trees are about 1.3m tall, the trees become much bushier.

Propagation

Moringa can be grown easily from seeds or cutting seeds should be planted 20 cm deep and ought to germinate within 1-2 weeks. Germination rates are usually very good, but can drop to 0% after 2 years. Dr. Jahu reported on work in the Sandan that showed that

optimum light for germination of all moringa species is half shade. When sown in the hotter weather of mid-April, germination percentages for M. Stenopetala and *M. oleifera* were only 54 and 40 percent compared to 92 and 94 percent in half shade. During the cool dry season there was little difference. Both *M. Oleifera* and *M. Stemopetala* propagation can be started from cuttings. Cuttings of 45 cm-100 cm long with stems 20 cm-40 cm wide should be taken from the woody parts of the branches. It should be wood from the previous year. Cutting can be cured for 3 days in the shade and then planted in a nursery or in the field. However, you should note that trees grown from cutting are known to have much shorter roots. Where longer roots are at vantage for stabilization or access to water and seedlings are clearly preferable.

Spacies of Moringa

Moringa arborea Verdc (Kenya)
Moringa borziona Mattel
Moringa Concanensis Nimmo
Moringa drouhardii Jum – Bottle tree south western Madagascar
Moringa Wildebrandtii Engl – Hildebrandt's Moringa
Moringa longtituba Engl
Moringa oleifera Lam (*Syn M. Pterygospernia*) – Horseradish tree (North western India)
Moringa ovalifolia Dinter & Berger
Moringa Peregrina (Fovssk) Flori
Moringa Pygmaea Verdc
Moringa Rivae Chiov
Moringa ruspoliana Engl
Moringa Stenopetala (Baker F.) Cufod

Products

Moringa Oleitera Seed
Moringa Leaves Powder
Moringa Capsules
Moringa Pod (fruit) or Drumsticks
Moringa Dry Leaves
Moringa Fruit powder or Moringa Pod Powder
Moringa Seed Powder or Moringa Seed cake
Moringa Tea
Moringa Tree Gum or Drumstick tree gum
Moringa Tree Roots or Drumstick tree root
Moringa Oil or Ben oil among other products.

Seed Sources
The Banana Tree
715 Northampton St
Easton, Pa 18042, 610/253-9589
http://www.banana-tree.com

Carter Seeds
1611 – A So Melrose Dr.
l, Vista CA 92083, 800/872-7711
Htt://wwwcaterseeds.com

Hurov's Seeds & Botanicals
P.O Box 1596,
Chula Vista CA, 91912, 619/690 – 1741

Ellison Hortocultural PTY ltd 267 Rous Road
A/ Stonville NSW 2477 Australia P: 6144 – 214255
5.Harti Nursery (for bulk orders) 25 1st Fl Raji Medical Blds,
1130ENV Rd ERODE, 638009, TN INDIA
Pi91-424-261815, fax 91 – 424 – 267588
Email: kodis@eth.net

Kumar International, Ajitmal 206121, Etawah Uttar Pradesh, India
7. Shivalik Seeds Corporation, 47 panditwari
P.O. Prem Nagar, Dehra Dun-248007, O.P
India, tel. 91-135-683-348, fax 91-135-683-776,
Email: hilander@delz.vxnl.net.in

Samuel Ratnam, India Foreign Trading Co. (Block 79A. Indus Road
04 – 4181420
Singapore, Tel: 0316 p2722 711, Fax 2716118)

Kenya Forestry Research Institute KEFRI) P.O Box 20412, Nairobi,
Kenya, Tel: (254) 154-32891, Fax (254) 154-32 844,
Email: Kefri@arcc.or,ike

Anzaria National Tree Seed Programme
P.O. Box 373, Morogoro, Tanzania
Tel: (255) 56-3192 or 255-56 – 3903,
Fax (255) – 56 – 5275, Email: ntsp@twiga.com

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MAIZE

General Cropping Plan

Maize is multiplied by direct sowing of the seed. The growth cycle varies in the tropics from 90 days-130 days or longer in high altitude regions. In outline, the cultivation of maize involves five main operations. Land preparation, sowing, maintenance of the crop, harvesting and storage.

Land Preparation

Where maize alone is grown, the soil will be cleared of the residues of the preceding crops and loosened to an adequate depth (if possible 20 cm to 25 cm) after an organic or phosphorus/potassium fertilizer has been ploughed in prior to sowing the land is worked down and the seed bed is prepared. Under certain circumstance, only the seeding row will be subject to preparatory cultivations, in line with the minimum cultivation approach. This will also apply to intercropping maize.

Sowing

The variety should be chosen according to its suitability for the region and the intended use of the crop. The seed should be clean disease-free and with a good germination capacity. It should be treated by coating with insecticides/fungicidal preparation. General or localized treatment of the soil with an insecticide may be required in certain cases. Sowing density is an important consideration. It will vary between 15 kg and 25 kg of seed to the hectare where maize is grown by itself and from a few kg to 10 kg where intercropping is practiced. Where maize is grown by itself, the seed should be sown 20 cm to 50 cm apart in rows, the distance depends on groups of 3 or 4 per seed hole. The rows themselves will be spaced some 80cm apart. The depth of sowing varies from 2 cm to 6 cm depending of the soil type, where the ground is light, seeds should be buried deeper. The date of sowing should be chosen carefully, earliness if often an advantage but it is advisable to wait until the rain has sufficiently moistened the soil deep down.

Crop Maintenance

Hoeing weeds is essential to effect on the growth of the maize and on the final yield is particularly marked. Hoeing is essentially done for the first time smoothly after emergence (ten days). A second hoeing sometimes continued with a slight earthling up, taking place at booting (30 days to 40 days after), sometimes a third hoeing/earthling up operation or weeding will be necessary. In some cases the use of herbicides may be advantageously replace hoeing. Where possible, provision must be made for irrigation of the crop, particularly at the time

of flowering. A supplementary application of nitrogen at sowing or prior to booting is nearly always essential to ensure a good crop. The fertilizer must be incorporated after it has been applied.

Harvesting
The ears may be harvested when they are still green i.e before that are matured. This begins when the grains can no longer be scratched with the fingernail and the spathes are turning yellow. Maize may be harvested either by hand, American hook or machines, which depend on either harvest of just the ears or the grain directly.

Storage
Once the ears have been harvested, they are dried either naturally or artificially in granaries or in special open sheds known as cribs. After shedding, the dried maize grain is stored in bulk, in sacks or in silos

Intercropping of Maize
The cultivation of maize in combination with other plants is a widespread practice in the tropics. In this part of the country, maize is intercropped with climbing beans and “egusi” melon. When the plants are in full growth, the combination therefore consists of a dominant maize plant, the stem of which serves as a support for the climbing bean plant, at the foot of which the melon leaves are spread out. The maize which required a lot of light does not suffer much competition from the other plants and also support the growth of the beans. The melon protects the soil from any erosion harm which might be done by the sun or rain.

PEPPER
Chilli Peppers, *Capsicum spp*, belong to the family *Slanaccae*, Out of the 4 species of *Capsicum*, 2 *Capsicum annum* (Sweet pepper) and *Capsicum frutescent* (red pepper) are widely cultivated. Sweet peppers with their wild flavor are eaten raw in salads and cooked in various ways. The red peppers provide the culinary purposes and seasonings in food. The sweet pepper is usually large fruited. In contrast the red peppers are usually smaller than the sweet peppers, brighter in color with a wide range of shapes and sizes. Pungency is greater that in sweet pepper.

Planting
No special seed treatment is required other than the seeds being extracted from matured fruits, and should be well cleaned and properly kept before sowing. The seed bed for raising seedlings is made 120 cm-150 cm wide and as long as necessary. The soil is pulverized by forking and breaking up the clods and removing stows and straw. A compound

fertilizer 15.15.15 is applied at the rate of 22 g/m^2. Seeds are then sown thinly in drills about 10cm and with one seed per centimeter. After sowing, the bed is mulched heavily but carefully watered so as not to wash out the seed. The mulch is removed when the seedlings emerge. In the rainy season the beds should be raised about 15cm above the surrounding ground and lowered during the dry season for water retention. For the red pepper grown during the dry season the site must be near a good source of water for irrigation, although peppers are able to withstand longer period of drought than tomatoes and egg plants. Most pepper are grown as rain fed crops and are therefore planted at the beginning of the rains. Ridge size for growing peppers may be 75 cm-90 cm with an interplant spacing of 60 cm. When plated on the flat soil, a closer spacing of 60 cm X 60 cm and 60cm X 30cm may be adopted for sweet and chili peppers respectively.

Fertilizer application

About a week before transplanting, the soil should be cultivated deeply and a generous amount of farmyard manual should be applied. In addition 250-500 kg/ha of a compound fertilizer 15.15.15 should be added to the soil before ridging. A top-dressing of 65 kg N/ha away be given in two doses at two weeks after transplanting and at the first set of fruits. Too much nitrogen may cause a poor fruit set

Weed Control

Weed should be removed as often as necessary, molding materials may be applied to suppress weeds and conserve moisture. Two or three hoe weeding may be done, but cultivation should not be too deep, to avoid damaging the root system. A number of herbicides have been found to consistently combine effective weed control with high yield comparable with those achieved with hoe weeding.

Pests and Diseases

White flies and aphides are major pests of pepper and are vectors of the most common disease of the crop, the pepper mosaic virus. White flies and aphids may be controlled by applications of contact insecticides. Control of the mosaic virus lies in the use of resistant chili varieties.

Harvesting and Storage

Fruit peppers are generally picked green while the hot types are harvested red-ripe. However, the time of harvest is determined by use. The skin of matured green peppers is shiny, waxy and fairly crisp. Hot peppers may be dried in the sun and stored to be sold later as dried chilies.

TOMATO

The cultivated tomato *Lyco persicon lycopersicum* belongs to the family *Solanaceae*. Tomato can be eaten raw or cooked. Large quantities are used to produce soups, juice, sauces, ketchups, purees and pastes. They are also used in the canning industries and green tomatoes are used for pickles and preserves. The seed which is extracted from the pulp and residues of the caning industries contain oil which is used for salad dressing and in the manufacture of margarine and soap. The residual press cake is used as stock feed and as a fertilizer.

Types of Tomato

There are five recognized varieties of tomato

1. Cherry tomato Var. *Cerasiforme*
2. Poor tomato Var. *Pyriforme*
3. Potato-leafed tomato Var. *Grandifolium*
4. Upright or tree tomato Var. *Alidum*
5. Common tomato Var. *Commune*

Planting

The land on which tomatoes are to be grown should be free draining, fertile and a sand-loam. The land should be cleared and deeply cultivated well ahead of time. Where available farmyard manure could be incorporated into the soil. Otherwise, a compound NPK Fertilizer could be used. Tomato seedlings can be raised in seedlings, on the ground or in seed boxes. Before sowing, a seed drill is used to draw planting hoes at 7.5 cm – 10 cm apart and 10mm deep. The seeds are sown thinly at 3 – 4 seed per 25 cm to avoid overcrowding and then covered lightly with grass or other shade material. Once the seedlings have emerged, the shade is removed. The seedlings are ready for transplanting when they are about 10 cm-15 cm high and have developed three true leaves. About 3 hours before transplanting, the seedlings should be soaked well. Transplanting is done in the late afternoon and the seedlings are lifted with a hand-fork or trowel. Transplanting positions should be marked out with spacing on the ridges of 60 cm between plants and on beds 60 cm X 60 cm. The seedlings should be watered immediately after transplanting.

Fertilizer Application

Where available, farmyard manual or compost should be applied during land preparation and allowed to decompose thoroughly before planting the seedlings. In the absence of these organic sources, an NPK compound fertilizer should be used. Once transplanting is completed,

nitrogen is applied as a top dressing at a rate of 250 kg/ha, in two equal doses at two and five weeks after transplanting.

Staking

Tomatoes required staking when the variety has stem which are weak and therefore unable to carry the weight of heavy fruits. Fruits of tomato product from staked plant often suffer less from fungal infections and are cleaner.

Weed Control

Weeds must be removed as often as possible during the early stages of growth. Hoe weeding may be done twice before fruiting and once thereafter making sure that plants that have spread out in the row are not damaged. A number of herbicides have been found suitable for the control of weeds in tomato fields. For instance metribuzin at 0.5 kg/ha or metdachlor plus metobromuron at 1.0 + 1.0 kg/ha followed by two or three hoe weeding have been found to control weeds and results in increased yields.

Pests and Diseases

The common insect pests which attack tomatoes are white flies, aphids and fruit worms. The major diseases include wilts, virus disease, leaf and stem spots and blossom and storage rots. Nematodes can also be a problem. Carbaryl is used to control aphids, fruit worm and white flies while Basamid is used to control nematodes. Sanitation of nursery beds and crop rotation may reduce the incidence of damping off of seedlings and foot-rot of growing plants.

Harvesting and storage

At physiological maturity, the crop may be harvested at two stages of fruit ripening: Vine-ripe or medium ripe. Vine ripe fruits are meant for sale within one or two days in close-by markets, while medium ripe harvesting allows for a longer shelf life and a greater distance of transportation.

PAWPAW

The papaya is a large, tree-like plant, with a single stem growing from 5 to 10 m tall, with spirally arranged leaves confined to the top of the trunk. The lower trunk is conspicuously scarred where leaves and fruit were borne. The leaves are large, 50–70 cm in diameter, deeply palmately lobed, with seven lobes. Unusually for such large plants, the trees are dioecious. The tree is usually unbranched, unless lopped. The flowers are similar in shape to the flowers of the Plumeria, but are much smaller

and wax-like. They appear on the axils of the leaves, maturing into large fruit - 15–45 cm long and 10–30 cm in diameter. The fruit is ripe when it feels soft (as soft as a ripe avocado or a bit softer) and its skin has attained an amber to orange hue.

Major Varieties

Honey Dew: This is an Indian variety of medium height that produces oval juicy medium size fruit.

Kiru: Is a Tanzanian variety that produces large fruits. It is a high yielder of papain.

Mountain: originally the name for a variety grown at high altitudes with very small fruits only suitable for jam and preserves. Now the name is also used for a medium size variety with good fresh consumption qualities such as firm sweet tasting yellow flesh.

Solo: Is a Hawaiian variety that produces small round very sweet fruits with uniform size and shape. It is hermaphroditic.

Sunrise Solo: Hawaiin variety that produces smooth pear shaped fruit of high quality, weighing 400 to 650 g. The flesh is reddish orange. This variety is high yielding.

Sunset: Hawaiian variety with red flesh and having same characteristics as 'Solo'

Waimanalo: another Hawaiian variety that produces smooth, shiny round fruits with short neck and is of high quality. The flesh is orange yellow, thick, sweet and firm.

Climatic Requirements

The pawpaw is a tree of temperate humid zones, requiring warm to hot summers, mild to cold winters, and roughly 80 cm of annual rainfall, with the majority falling in spring and summer. It is hardy to zone 5 (-25 °C). Papaya thrives in warm areas with adequate rainfall and a temperature range of 21-33 °C. Its altitude range is similar to that of the banana, from sea level to elevations at which frosts occur (often around 1600 m). However they grow best in areas below 1000 m. Although the pawpaw is capable of fruiting in the shade, it performs best on sites with full-sun exposure, but with some protection from wind (because of its large leaves). Seedlings, however, will not survive under full sun conditions because the young shoot is extremely sensitive to sunlight. Shading for the first year, and sometimes the second, is usually required. It is for this reason that in the wild pawpaws are primarily understory trees. The quality and yield are low at higher altitudes. Frost can kill the plant, and cool and overcast weather delays fruit ripening and depresses fruit quality. Fruit tastes much better when grown during a warm sunny season. Evenly distributed annual rainfall of 1200 mm is sufficient if

water conservation practices are employed. Plantations should be in sheltered locations or surrounded by windbreaks; strong winds are detrimental, particularly on sandy soils, as they cannot make up for large transpiration losses.

Soil Requirements

Pawpaws grow best in slightly acid (pH 5.5-7.0), deep, fertile, and well-drained soils. Good drainage is essential to success. Pawpaws will grow in heavy soils but will not survive water-logged conditions. In habit the tree is small, seldom taller than 7.5 m. Grown in full sun, the pawpaw tree develops a pyramidal shape, with dense, drooping foliage down to ground level. In the shade it has a more open branching habit, with few lower limbs and horizontally held leaves.

Plant Selection and Establishment

Pawpaws are available from nurseries as bare-root and container-grown trees. Container-grown trees have given the best results. The trees can also be transplanted from the wild or propagated in a variety of ways. Extra care should be given trees for the first two years to promote growth as the root system establishes itself. Keep the plants well watered and partially shaded for the first year or two. Thereafter, growth accelerates and trees require little care. Fruit production normally begins when the trees reaches 2m, usually after five to seven years.

Transplanting

The pawpaw is very difficult to transplant. It would seem natural to propagate a clone by transplanting root suckers, since pawpaws commonly sucker from the roots, but in practice this is extremely difficult and usually ends in failure. The root suckers normally have no secondary roots for a great distance from the shoot. Without secondary roots, the shock of transplant is too great, and the root sucker dies. Seedling trees, on the other hand, have been successfully transplanted. Experience has shown that to be successful, seedlings should be transplanted in the spring, at the time that new growth commences or soon after. If many roots are damaged, it may be desirable to prune the top to bring it into balance with the remaining roots. While for many species a bare-root tree is sufficient for transplanting, it is not preferred for pawpaw. Though difficult to transplant, once established, the pawpaw is vigorous and easy to maintain. The key to successful transplanting from the wild lies in five rules:

1. Transplant seedlings for best results.
2. Keep the roots and soil intact as much as possible.

3. Transplant in the early morning or in the evening when the sun is down.
4. Plant in a well-drained site, and keep trees well watered the first year.
5. Provide partial shading for the first year or two.

Planting

Papaya is propagated by seed. To reproduce the desired characteristics it is best to get seeds through controlled pollination. The fleshy outer layer of the seed coat (sarcotesta) enveloping the seed is removed because it inhibits germination. This is achieved by rubbing the seed together against a fine-meshed screen under running water. Thoroughly dried seeds stored in air-tight containers remain viable for several years.
Seeds are sown in small containers (tin cans, plastic bags or paper cups) at the rate of 3-4 seeds per container. Use of sterilized soil minimizes losses resulting from nematodes and damping-off fungi. Germination takes 2-3 weeks. Another practice is to sow the seeds in sterilized nursery beds and to prick out at the 2-3-leaf stage, transferring 3-4 seedlings to each container. Seedlings are transplanted about 2 months after sowing when they reach the 3-4-leaf stage or 20 cm height, preferably at the onset of the rainy season. During transplanting, take care not to disturb the roots. Older seedlings recover poorly after planting out.

Vegetative Propagation

Pawpaws are easily propagated by a number of grafting and budding techniques, such as whip-and- tongue, cleft graft, bark inlay, and chip budding. Shoot cuttings have proven virtually impossible to root. Grafting scions of known cultivars or selections from the wild that exhibit desirable traits onto seed- ling rootstocks is one of the best method of establishing pawpaw trees.

Seed Propagation

Pawpaw seed is slow to germinate, but germination is not difficult if certain precautions are followed. Do not allow the seed to dry out, because this eventually destroys the immature dormant embryo. To break dormancy, the seed must receive a period of cold temperatures (termed “stratification”) lasting 90 to 120 days.
Stratification may be accomplished by sowing the seed outdoors in the garden bed in the fall and letting the seed overwinter there; the seed will germinate the following year in late July or August. Or the seed may be stratified in the refrigerator at 0-5°C. The seed should be stored in plastic bags containing slightly moistened sphagnum moss to keep the seed

moist and to suppress fungal/ bacterial growth. After 90-120 days, the seed should be removed from the refrigerator and sown in a well-aerated soil mix of pH 5.5-7.0 with an optimum temperature of 25-30°C. On average the root will emerge from the seed coat after 18 to 24 days, develop into a taproot about 32 cm long, and then send up a shoot after 50-60 days. Germination is “hypogeal,” meaning that the shoot emerges without cotyledons.

Pollination and Fruit Set

Pollination is the major limitation to pawpaw fruit set. The flowers are “protogynous,” meaning that the stigma (the female receptive organ) ripens before the pollen does and is no longer receptive when the pollen is shed. Thus, the flower’s design insures that the flower will not pollinate itself. In addition, pawpaw trees are usually self-incompatible, requiring pollen from a genetically different tree in order to be fertilized. Finally, the natural pollinators of the pawpaw (various species of flies and beetles) are neither efficient nor dependable. Although it requires a little extra labor, hand pollination can be well worth the effort. With a small, flexible artists brush, transfer a quantity of fresh pollen from the anthers of a flower of one clone to the ripe stigma of the flower of another clone. Pollen is ripe when the anthers are brown in color, loose, and crumbly, and pollen grains appear as yellow dust on the brush hairs. The stigma is ripe when the tips of the pistils are green and glossy, and the anther ball is still hard and green. Hand pollination can lead to excessive fruit set. Do not overcrop the tree by leaving too much fruit, because this stresses the tree, resulting in small fruit, reduced tree growth, and possible limb breakage.

Weeding

Weeding Weed contol is very important especially during the first 3 months after transplanting. This may be achieved by hoe weeding, slashing at monthly intervals, or by the use of the herbicide Paraquat glyphosate at 4-6 or 3 kg active ingredient per hectare. Dry season irrigation is important for pawpaw. For newly transplanted seedlings, apply 3 liters of water per plant twice a week, For flowering plants, apply 5 liters twice a week, and for bearing plants apply 15 liters of water per plant once a week.

Ripeness and Quality

Ripe pawpaws have a pronounced aroma that is fruity and floral. The flavor is sweet, fragrant, and complex, with a lingering aftertaste. When ripe, the fruits are soft, like a ripe avocado or peach. Visual clues of ripeness are sometimes subtle. The skin turns a lighter shade of green

and may show some yellow. In the late stages of ripeness the skin develops brown blotches, streaks, and freckles like a banana. The flesh of a ripe pawpaw will be yellow, soft, and smooth, resembling custard. Fruit can vary considerably in size, depending on the cultivar and the number of seeds in each fruit, but normally weighs between 5 ounces and 1 pound. Fruit shape is oblong to round, depending on the number of seeds.

Harvesting

The stage of physiological development at the time of harvest determines the flavor and taste of the ripened fruit. The appearance of traces of yellow color on the fruit indicates that it is ready for harvesting. Fruits harvested early have longer postharvest life, but give abnormal taste and flavor. The fruits also tend to shrivel and suffer chilling injuries when refrigerated. The fruit is twisted until the stalk snaps off or cut with a sharp knife. Yields per tree vary from 30 to 150 fruits annually, giving 35 to 50 tons of fruit per ha per year. A papaya plantation can be productive for over 10 years but the economical period is only the first 3 to 4 years. For pawpaws production, latex is collected by tapping the green unripe fruit. Four longitudinal incisions, skin-deep and 2 to 3 cm apart are made with a sharp, non-corrosive rod (glass, plastic or horn). Latex is collected in a clean glass or porcelain container and dried, or a canvas covered tray fixed onto the trunk of the tree. The latex is later scraped off the canvas with a wooden scraper and dried. Fruits may be tapped once a week, until they show signs of ripening. The operation is best done early in the morning because the latex flows slowly in hot weather. Tapping results in ugly scars on the fruit, although quality is unaffected. Tapped fruit can be processed or used as animal feed. The papain producing trees are productive for 2 to 3 years, with the first 2 years being the most productive. If kept longer production is uneconomical.

Storage

Pawpaws are very perishable. Their respiration rate is higher than that of most fruits, and the respiration process emits quite a bit of moisture, heat, carbon dioxide, and ethylene (the fruit-ripening hormone). When completely ripe, pawpaws will last for only about two days at room temperature. Refrigerated at 0-4 °C, the same fruits may last a week. If the fruits are not quite ripe, they may be refrigerated for about two weeks and then ripened at room temperature for several days. Storing pawpaws at less than 4 °C is not recommended, since it often changes the flavor, producing undesirable flavors.

Pests

In its native habitat the pawpaw has few pests of economic importance. The worst pest is *Talponia plummeriana* , the pawpaw peduncle borer, a small moth larva (about 5mm long) that burrows in the fleshy tissues of the flower, causing the flower to wither and drop. In some years this borer is capable of destroying the majority of blossoms. Other pests include *Eurytides marcellus*, the Zebra Swallowtail Butterfly, whose larvae feeds exclusively on young pawpaw foliage, but never in great numbers. The adult butterfly is of such great beauty that this should be thought more a blessing than a curse. Sometimes the fruit surface may be covered with hard black patches that are caused by a fungus infection, but seldom does this have any effect on flavor or edibility.

Uses of Pawpaw Fruit

The primary use of pawpaw is for fresh eating. The easiest way to eat them is to cut them in half and scoop the flesh out with a spoon. The large seeds, scattered throughout the fruit, are easily separated from the flesh. In cooking, the pawpaw is best suited to recipes that require little or no heat. Because the pawpaw's flavor compounds are very volatile, prolonged heating or high temperatures destroy the characteristic flavor. Pawpaw works well in ice cream, sorbet, chiffon pie, and mousse, and combines well with mint. Because of its flavor resemblance to banana, it may be substituted in recipes for such things as banana bread. Papaya fruit is a source of nutrients such as provitamin A carotenoids, vitamin C, folate and dietary fiber. Papaya skin, pulp and seeds also contain a variety of phytochemicals, including lycopene and polyphenols. In preliminary research, danielone, a phytoalexin found in papaya fruit, showed antifungal activity against *Colletotrichum gloesporioides*, a pathogenic fungus of papaya. The ripe fruit of the papaya is usually eaten raw, without skin or seeds. The unripe green fruit can be eaten cooked, usually in curries, salads, and stews. Green papaya is used in Southeast Asian cooking, both raw and cooked. In Thai cuisine, papaya is used to make Thai salads such as som tam and Thai curries such as kaeng som when still not fully ripe. In Indonesian cuisine, the unripe green fruits and young leaves are boiled for use as part of salad, while the flower buds are sautéed and stir-fried with chillies and green tomatoes as Minahasan papaya flower vegetable dish. Papayas have a relatively high amount of pectin, which can be used to make jellies. The smell of ripe, fresh papaya flesh can strike some people as unpleasant. In Brazil, the unripe fruits are often used to make sweets or preserves. The black seeds of the papaya are edible and have a sharp, spicy taste. They are sometimes ground and used as a substitute for black pepper.

In some parts of Asia, the young leaves of the papaya are steamed and eaten like spinach.

MANGO PRODUCTION

The mango is a juicy stone fruit belonging to the genus *Mangifera*, consisting of numerous tropical fruiting trees, cultivated mostly for edible fruit. The majority of these species are found in nature as wild mangoes. They all belong to the *Anacardiaceae* and are native to Asia, particularly eastern India, Burma and Andaman Islands from where it spread to other parts of the world. But while the Persians introduced it to East Africa in the 10th Century, the Portuguese were responsible for its introduction to West Africa in the 16th Century. Mango came to Nigeria in the 20th Century through itinerant merchant missionaries and colonialists where it has become an integral part of indigenous cropping systems. The guinea and sudan savanna zones of Nigeria are credited with producing greater percentage of the fruit in Nigeria with Benue state topping the list. Unfortunately, the history of mango production in the state is not very clear. Reports however indicate that improved mango varieties were introduced to Yandev Farm Centre by the early Agricultural Officers from Zaria and Ibadan in the 1950s. The mango tree produces a fruit with great diversity with respect to form, size, colour and quality. The fruit can be put to a number of uses. For instance, ripe fruits can be made into juice and preserves, while unripe fruits can be processed into pickles and chutney. However, in Nigeria, most of the fruit produced is consumed as fresh fruit.

Although Nigeria occupies the 9th position among the ten leading mango producing countries of the world, she does not feature among the ten leading mango fruit exporters. The fruit pulp which makes up 60-75 % of fresh fruit weight contains 15 % sugars, high amounts of vitamin A and some quantities of vitamins B and C. Mangoes are produced in over 90 countries worldwide. Asia accounts for approximately 77 % of global mango production, and the Americas and Africa account for approximately 13 % and 9 %, respectively. The mango has been the most popular tropical fruit since 2000 BC or earlier. It is a fleshy stone fruit belonging to the genus *Mangifera*, consisting of numerous tropical fruit trees in the flowering plant family Anacardiaceae. The mango is, actually, native to the Indian subcontinent from where it spread all over the world and is one of the most cultivated fruits in the tropics. While other *Mangifera* species (e.g. horse mango, *M. foetida*) are also grown on a more localized basis, *Mangifera indica* – the common mango or Indian mango – is the only mango tree commonly cultivated in many tropical and subtropical regions. There are over 400 varieties of mango

throughout the world. In Nigeria we have some variants like Kerosene mango (the ellipse-shaped lime-green specie with an aftertaste) and the much loved Sheri mango (the yellow to orange delicious and fleshy kind). The outer skin of a mango is smooth and green when un-ripe mangoes but turns into golden yellow, bright yellow or orange-red when ripened depending on the cultivar (like the Kerosene mango, which remains green even when ripe). The mango is known as the 'king of fruit' throughout the world. The name 'mango' is derived from the Tamil word 'mangkay' or 'man-gay'.

Mangoes are grown in 85 countries and 63 countries with over 20 million metric tons of mangos grown throughout the tropical and sub-tropical world, with developing countries accounting for about 98% of total production.. Nigeria still occupies the 8th position in the world ranking of mango producing countries as at 2006.The main producing states in the country include Benue. Jigawa, Plateau, Yobe, kebbi, Niger, Kaduna, Kano, Bauchi, Sokoto, Adamawa, Taraba and FCT. Nigeria has greater potentials over other world suppliers of tropical mangoes. This is in terms of the year round favorable agricultural and climate conditions. The obviously high input cost is usually most compensated by the steadily rising of export mangoes.

Description

The mango is an erect, branched, medium to large-sized tree with alternately arranged evergreen or nearly evergreen leaves, with a wide crown and inflorescences having numerous flowers. Mango trees grow up to 35–40 m tall, with a crown radius of 10 m. The trees are long-lived, as some specimens still fruit after 300 years. In deep soil, the taproot descends to a depth of 6 m, with profuse, wide-spreading feeder roots; the tree also sends down many anchor roots, which penetrate several feet of soil. The leaves are evergreen, alternate, simple, 15–35 cm long, and 6–16 cm broad; when the leaves are young they are orange-pink, rapidly changing to a dark, glossy red, then dark green as they mature. The flowers are produced in terminal panicles 10–40 cm long; each flower is small and white with five petals 5–10 mm long, with a mild, sweet odor suggestive of lily of the valley. Over 400 varieties of mangoes are known, many of which ripen in summer, while some give double crop. The fruit takes three to six months to ripen. The ripe fruit varies in size and color. Cultivars are variously yellow, orange, red, or green, and carry a single flat, oblong pit that can be fibrous or hairy on the surface, and which does not separate easily from the pulp. Ripe, unpeeled mangoes give off a distinctive resinous, sweet smell. Inside

the pit 1–2 mm thick is a thin lining covering a single seed, 4–7 mm long. The seed contains the plant embryo.

Soil Requirements for Growing Mango

Mango grows and fruits best on a deep, well-drained fertile soil but will grow and produce on a wide variety of soil types. The plant has a strong vigorous rooting system which will penetrate a large area to obtain nutrients. Mangoes require deep soils with good drainage not necessarily fertile but mangoes can thrive in a wide range of soil types.

Climate Requirements

The plant will thrive in rainfall ranging between 30 to 100 inches per year, but for maximum fruit production a prolonged and severe dry season is necessary. Mangoes are very prone to irregular or biannual bearing and this habit varies between varieties. Although no cause or solution has yet been found for this climatic conditions appear to have considerable effect on this characteristic. The longer and more severe the dry season, the more regular is the cropping habit. The mango is adapted to both tropical and subtropical conditions. Temperature range is 21- 25 ^{o}C. Rainfall of at least 600 mm/year and an altitude of 1,500-2,000 m are ideal for the crop. The crop is intolerant to saline conditions. A dry period of at least 3 months is necessary for flowering. The tree requires plenty of sunshine for optimum growth and fruiting.

Types/Varieties

Medium canopy and fairly early yielding varieties include; Zillate, Pinero, Alfonso, Apple, Kent, Keitt, while other known varieties are Amelia, Apple Haden, Ruby. Findings indicate that all the types thrive and yield highly under the prevalent agricultural and climatic conditions of Nigeria. In the northern parts of Nigeria, some beautiful species are as fat as “human head”

Management Practices Propagation

It is highly recommended that planting materials for the improved mango varieties should be grafted or budded (shoot joined on rootstock). This practice reduces time to flowering to 2-3 years instead of 6-7 years if seed is planted. Suitable rootstocks are used which withstand soil born diseases. Most trees bear 2 times a year.

Spacing

Mango spacing depends on the rainfall pattern and soil fertility. The recommended spacing for optimum plant population is 8 m x 8 m giving 144 plants per hectare (58 plants per acre).

Planting

Planting Medium fine field is adequate. Dig holes 60 cm deep and 60 cm wide while separating top soil from sub (red) soil. Mix well decomposed manure with top soil at 1:1 ratio and put back into the hole to cover the first 30 cm. Make a small hole within and plant in the grafted seedling. The plastic bags used for potting should be removed before planting. Each plant should be mulched around and a cage or perimeter fencing put in place to avoid damage by animals. One month after transplanting, the grafting tape should be removed. Any shoots which grow below the point of union should also be removed.

Watering

When planting is done during low rainfall season, the young plants should be watered at least once a week to avoid drying. It is also advisable to give water during flowering, where possible, to avoid flower abortion. Watering after fruit set reduces fruit abortion and increases fruit size.

Fertilizer Requirements

Apply manure once a year at the beginning of the rainy season. Put at least 2 tins per tree, applied around one meter from the tree. Avoid putting too much nitrogen fertilizers to your mango plants during productive stage. Smoking in the field and cutting the bark of the tree encourages flowering.

Pruning Mangoes

Periodic inspections of the newly planted tree are necessary to insure that growth from the stock region does not grow up and weaken the scion. This is most likely to occur during the first year's growth. All growth originating below the graft union must be gradually removed. Little pruning of young trees is necessary except for the removal of dead or dying branches; when removing branches, cut cleanly back to the branch origin without leaving a stub. Some pruning paint or tar should be used over the cut surface to protect the wound from rotting and insure good healing. Deflowering of young newly-planted grafted trees, particularly Julie, is recommended as a stress-removal procedure.

Weed Management

Slash the orchard regularly. Do not dig through as this will damage roots and cause root rot diseases. Where mulching materials are available, mulching is encouraged.

Production

Depending on the variety, the time from flowering to maturity is 100-150 days. Under good management 400-600 fruits per tree per year can be produced. Yield range is 10-16 ton/ha depending on management, variety and age of orchard. In the case of improved varieties, fruits can weigh 0.3 – 2 kg each.

Harvesting and Storing Mangoes

Harvest mature fruits and with smooth, undamaged skin are harvested using a long stick with a knife and basket at the tip or just long stick with knife and clothes or polythene spread below, off ground to trap falling fruits for tall trees. Collect fruits in a wooden box with smooth inner surface. Avoid picking fruits from the ground. Most mango varieties can be picked several days before ripening and be of good quality. Julie mango must be picked very close to ripening for best quality so that a particular tree should be harvested over a 2-3 day interval. Fruits should be hand-picked and handled gently at all times to avoid bruising. Long handled bags can be used to pick fruits high up on trees. After picking, fruits should be packed in rigid 30 lb. containers (wood or plastic) that are lined with a soft material such as straw or polyfoam. Anthracnose spot- ting of ripe fruits can occur and this renders fruits unsightly and unsalable. This problem can be reduced or eliminated by hot water treatment of fruits after harvesting, at a temperature of 51 ºC to 51.5 ºC for 15 minutes. The temperature and timing for this treatment are critical. If exceeded, fruit injury will result but treatment is also ineffective if the correct temperature and time are not observed. Mangoes may be cold stored before ripening at 10 ºC and after ripening from 7.2 ºC to 10 ºC. Below these temperatures chilling effects appear which include failure to ripen properly, anthracnose, spotting and other skin blemishes.

Insect Pests, Diseases and Their Control

Mango can be attacked by many diseases which reduce quality and yield. The major diseases of economic importance in Uganda are: anthracnose and powdery mildew.

Anthracnose: The disease attacks young shoots, flowers and fruits causing leaf spots, drying twig tips and dark spots on fruits. Black spots develop on fruits, which leads to cracking. Fruits infected at mature stage carry the fungus into storage and cause considerable loss during storage, transit and marketing. Wet conditions favor the disease. The fungus has long survival ability on dead plant parts.

Control: The diseased parts should be pruned and burnt. Remove rotting fruits from the orchard. Where the disease is severe, apply fungicides before flowers set to reduce flower infection. Fungicide such as Ridomil and Antracol alternated at 10-15 day intervals at quantities indicated on the package are recommended. Control and prevention is possible through use of resistant varieties.

Powdery mildew: The sign of the disease is the white powdery fungal growth on leaves, stalks and flowers. Rain and cool nights are favourable conditions for disease spread. Young leaves when infected develop white patches and later become curled and distorted. The fungus persists on older leaves and when conditions are favorable spores are blown onto susceptible tissue.

Control: Ridomil, Antracol or Thiovit sprays alternated with Dithane M45 at 10-15 day intervals at quantities indicated on the package is recommended for the control of the disease. Spraying can start at the signs and repeated after 2 weeks until fruit set. Once young tissue has hardened it is no longer susceptible and spraying can be stopped.

The major pests attacking mangoes include: fruit fly and mango seed weevil. Minor ones are scales and mealy bugs.

Fruit fly: This is one of the most serious pest of mango in the country affecting the marketing of fresh fruits. The female punctures the maturing fruits and lays eggs in small clusters inside the fruit. After hatching, the larvae feed on the fruit that appears normal from outside. The maggots later fall on the ground for further growth. When infested fruits are cut open, maggots of the fruit fly are seen in the damaged flesh.

Control: Collection and burying of infested and dropped fruits. Spray suitable insecticide at quantities indicated on the package e.g. Dimethoate, 7 weeks and 3 weeks before picking. Salut and Dursban can also be used.

Mango seed weevil: This is a serious pest of mangoes in the tropics. The female lays eggs on partially developed fruits. The eggs hatch and the maggots bore through the flesh into the seed where they feed and develop damaging the seed. There is a discoloration at the point of entry.

Control: Burying by removing fallen fruits and burying them in a pit. Spraying the trees, especially the stems, with a suitable insecticide e.g Dimethoate or Dursban at the quantity indicated on the package.

Uses of Mango

Mango fruit is rich in pre-biotic dietary fiber, vitamins, minerals, and poly-phenolic flavonoid antioxidant compounds. According to new research study, the mango has been found to help protect against colon, breast, leukemia and prostate cancers. Fresh mango is a very rich source of potassium. Potassium is an important component of cell and body fluids that helps controlling heart rate and blood pressure. It is also a very good source of vitamin-B6 (pyridoxine), vitamin-C and vitamin-E. Consumption of foods rich in vitamin C helps body develop resistance against infectious agents and scavenge harmful oxygen free radicals. Vitamin B-6 or pyridoxine is required for GABA hormone production in the brain. It also controls homocystiene levels in the blood, which may otherwise be harmful to blood vessels resulting in CAD and stroke.

Some specific health benefits of the mango:

1. Lower cancer risk. Mangoes contain a soluble dietary fiber called pectin. The pectin decreases the action of a protein called galectin 9 that is present in cancerous cells and plays an important role in cancer. The possibility of cancer in the gastrointestinal tract can be reduced by the intake of fiber. A compound in mangoes, known as lupeol is said to suppress the tumor cells of prostate cancer.
2. Digestion. Mango contains an enzyme which is said to help in digestion. Esters, terpenes and aldehydes are some of the bio-active ingredients present in the mangoes, which are said to increase appetite and also improve digestion. Eating a mango after a meal helps eliminate problems like indigestion and acidity.
3. Lower cholesterol. Mangoes contain a large amount of pectin, a soluble dietary fibre that efficiently lowers the blood cholesterol levels. Pectin also prevents you from having prostate cancer. The portion originating from pectin combines with galectin 3 (a protein playing significant role in all stages of cancer).
4. Cures anaemia & helps in pregnancy. Mangoes are rich in iron, so they are beneficial for people suffering from anaemia. Regular and adequate intake of mangoes helps to avoid anaemia by increasing the blood count in the body. Mangoes are also very beneficial for pregnant women as a natural source for iron, an extremely essential mineral.
5. Cures acne. Mangoes are related with skin enhancements, and is used as an ingredient in face masks, especially freshly homemade

ones. Other than bringing a glow to your face, this fruit also helps to lighten skin color. Mangoes also treat acne effectively as they open the clogged pores of the skin.

6. Brain Health. Mangoes have abundant quantities of vitamin B6, for maintaining and improving brain functions. These vitamins aid in the amalgamation of the major neurotransmitters that contribute in determining the mood and modification of sleeping patterns. The Glutamine acid content in mango improves concentration and memory power.
7. Body immunity. Mangoes are also rich in abundant quantities of beta-carotene, a carotenoid. This element helps in enhancing the immune system of the body and makes it strong. Vitamin A is an antioxidant and assures you protection against the innumerable free radicals that can harm your internal system.
8. Mango is highly medicinal: Every part of the mango is beneficial and has been utilized in folk remedies in some form or another. Whether the bark, leaves, skin or pit; all have been concocted into various types of treatments or preventatives down through the centuries. A partial list of the many medicinal properties and purported uses attributed to the mango tree are as follows: anti-viral, anti-parasitic, anti-septic, anti-tussive (cough), anti-asthmatic, expectorant, cardiotonic, contraceptive, aphrodisiac, hypotensive, laxative, stomachic (beneficial to digestion).

CITRUS PRODUCTION

Citrus is one of the most important fruit crop grown all over the world. Citrus fruits are rich in Vitamin C (ascorbic acid) and folic acid, as well as a good source of fiber. They are fat free, sodium free and cholesterol free. In addition they contain potassium, calcium, foliate, thiamin, niacin, vitamin B6 (pyridoxine), phosphorus, magnesium and copper. Citrus species are grown for the juice of their fruits. The commonly grown citrus species belong to the family Rutaceae. In Nigeria, about 930,000 tons of citrus fruits are produced annually from an estimated hectarage of 3 million hectares of land. Citrus is grown in the rainforest and guinea savannah, most of these farmlands is in the remote part of the country with poor roads. About 30-50% of these citrus fruit get spoilt on the way before getting to the final consumers in the urban centres. Citrus fruits are the highest value fruit crop in terms of international trade. There are two main markets for citrus fruit; the fresh fruit market and the processed citrus fruits market (mainly orange juice). Most citrus production is accounted for by oranges, but significant quantities of grape fruits, lemons and limes are also grown. While the origin of citrus fruits cannot be precisely identified, researchers believe they began to appear in

Southeast Asia around 4000BC. From there, they slowly spread to Northern Africa, mainly through migration and trade. Worldwide trade in citrus fruits did not appear until the 1800's and trade in orange juice developed as late as 1940. Total production and consumption of citrus has grown strongly since the 1980's. Current annual worldwide citrus production is estimated at over 105 million tons, with more than half of these being orange. The rise in citrus production is mainly due to the increase in cultivation areas, improvements in transportation and packaging, rising incomes and consumer preference for healthy food.

Major citrus producing states in Nigeria include Benue, Nassarawa, Kogi, Ogun, Oyo, Osun, Ebonyi, Kaduna, Taraba, Ekiti, Imo, Kwara, Edo, and Delta. Fruit industry in Nigeria began under the western Regional government of Chief Obafemi Awolowo in the 1950's. As a result of the down-turn in cocoa trade, consequent upon some pervasive microbiological attack, the government decided to start a pilot project in the cultivation of citrus and other fruits primarily as a way of providing farmers with an alternative source of income. Thus, the Lafia caning factory in Ibadan was born in 1954, and to feed the factory, there was the establishment of Apoje Citrus Farm, backed with an aggressive Farm settlement scheme. Interestingly, this has been bought by Funman Agricultural Product Ltd and it serves as its manufacturing base. From that small beginning in the 1950's, fruit juice manufacturing in Nigeria has taken a giant leap. This quantum leap was facilitated by the government's ban on the importation of fruit juice; a challenge to which the local manufacturers reacted positively by increasing their production quality and quantity-wise to meet what would have been a massive shortfall in aggregate supply.

Varieties

The most important Citrus species grown are;

Common name	Botanical names	Local names in Nigeria
Sweet orange	*Citrus sinensis*	Osan mimu, Orombo didun
Grape fruit	*Citrus paradisi*	Osan gerepu, Osan paya
Lime	*Citrus aurantifolia*	Osan-wewe, Afotanta, Epe nkirisi,
Lemon	*Citrus limon*	Osan-laimu, Oroma-nkirir
Tangerine	*Citrus reticulata*	
Sour orange	*Citrus aurantium*	Osan, orombo-igun,Olomaoyibo

Soil Requirements

Growing Citrus in Nigeria Site selection Sandy loam is best for the cultivation of Citrus. The most important factor in the choice of site is free/drainage of water. Soils with an underlying hardpan of about 1m or

less to the top mock soils, or slain sites are not suitable. Apart from these, citrus can be grown on a wide range of soil types. Citrus is not shade loving, therefore clear the site of all tree stumps and plough before setting in the plants.

Propagation

Citrus is almost entirely propagated by budding. Plant only budding seedlings in orchards as unbudded seedlings may not be true-to-type, and often takes a long time to fruit. They are also susceptible to disease attack. Obtain budling by selecting a required bud and uniting this with a suitable rootstock. Make sure the budlings are obtained from repured sources. Orchard establishment Plant the orchard when the rainy season has fully set in. In the south this is around May, but about June in the north. Complete planting holes, well in advance, before purchasing the budling. These holes should be 25 cm x 18 cm and 7 cm apart in either direction. Set the trees in these holes (which have been half–filled with rich topsoil) and shovel in back the soil firmly around the trees. Always ensure that the trees are planted no deeper than they had grown in the nursery. Irrigation Citrus trees will wilt and yield will be depressed unless moisture is provided during the long dry season of November to February. Therefore, make sure that the trees are watered during this period. Ten liters of water (stream water, well water, tap water, etc.) delivered at the base of the trees twice a week is sufficient for good development and yield.

Intercropping

Spacing of citrus (7 m x 7 m) is relatively wide and allows for considerable land to remain unproductive for some years while no income is obtained from citrus. At least for the first 3 years before citrus trees start fruiting the wide inter-row spaces can be cropped to compatible field crops such as pine- apple, water melon, egusi melon, cowpeas, okro, soya, sweet potato etc.

Fertilizer Requirements

Do not apply any organic fertilizer at planting or during the 1st year of planting in the orchard. Thereafter apply the following recommendation in a shallow furrow around the trees (corresponding to the drip-margin of the canopy). (a) 2–4 years of age: 500 grams of compound fertilizer N.P.K (15:15:15) per trees, twice in the year. (b) 5–10 years of age: 2 kg (15:15:15) + 600 grams k20 per tree, twice in the year.

Weed Control

Absolute weed control under a hot, humid climate may be very expensive, nevertheless there is need for some level of weed control. Slash the orchard at least 3 times in the year, the last being at the on-set of the dry season. In addition, ring weed individual trees constantly. Ring apply Diuron or Paracol to check weed growth.

Insect Pest Control

The control of insect pests on citrus depends on the stage of development. Nursery pests are mostly leaf-eating insects like caterpillars and plant 'bud'. Control the caterpillar with Cymbush, Ambush, Decis or Sherpa plus at the rate of 0.9–1.00 Liters E.C. formulation in 300 Liters of water per hectare. The fruit fly, fruit piercing moth, and 'bud' control can be achieved through effective intergrated approach with close supervision by experts.

Control of Fungal Diseases

There are two major diseases of citrus. A group affects leaves, stem and roots. The others are fruit diseases which originate from the field and continue at storage. Some of these diseases are twig or branch dieback, foot rot and Brown rot gummosis and blast. Control the fungal diseases by applying Benlate at 20 g/ 10 L water on the trees with any wetting agent. You can curtail fruit anthracnose and Phytophthora rot by applying either Thiabendazone at 10 ml/ 10 L water or Benlare at 10 g/ 10L water. In case of Gummosis, Scab and Root rot attack, seek the advice of crop protection experts.

GROUNDNUT

Cultivated groundnut is an erect semi-erect or trailing annual legume of 30 cm to 70 cm tall, belonging to the sub-family *Papilionaceal.* It is self pollinating, of indeterminate growth and bears fruits in an unusual way by forming pods beneath the soil surface. These basic traits determine its agronomic characteristics and hence the ways in which it is grown and its place in traditional farming systems.

Soil Preparation

Soil preparation before sowing groundnut involves removing crop residences that may harvest pest and diseases creating good conditions to promote seed germination and preventing weed emergence in the early stages of crop establishment.

Planting

Whether to plant groundnut on ridge or on the flat soil depends on local soil conditions, the availability of water and the possibility of soil erosion. In areas that are prone to water logging during the growing season it is advisable to plant the crop on ridges. The ridges should be spaced at 1cm apart to allow a closed canopy to form at the stage of peak leaf development. In areas with good drainage, the groundnut crop is often planted on the flat soil. As the production of pods is dependent on the fertilized pegs penetrating the soil, it is essential to till the soil to enhance pod formation. The Shelled groundnut seed is planted in holes on ridges or broad cast on the flat soil. Seeds should usually be sown at the beginning of the rains. The seed loses its viability soon after shelling, so should be planted as soon as possible. Seed from the 'runner' varieties require a period of dormancy before plating. Seed dressings are recommended to enhance the germination rate. Aldrex-T, a combination of insecticide and fungicide is recommended at the rate of 300 g / 100 kg of seed. Groundnuts are grown for cash in areas of predominantly subsistence agriculture, the time of planting has traditionally been after other food crops are sown, Groundnut are planted at densities of about 47,000 plants / ha (a spacing of 91 cm X 23 cm for individual plants)

Fertilizer Application

The nutrient requirements of groundnut are primarily a function of the variety used, the soil nutrient content, the climate or ecological location and the level of crop husbandry practiced. Groundnut production is relatively less sensitive to fertilizer application that other field crops, mainly because groundnut is very efficient in obtaining nutrients from the soil and so exploiting residual fertilizers from the soil and so exploiting residual fertilizers left from previous crops in a rotation. In this way the crop can become dangerously exhaustive if grown continuously, even though it is a legume and fixes nitrogen. The Current practice in West Africa is for applications of 54 kg of P_20_5 plus 50 kg of k_20/ha to all soils in the sudan savanna zone and 54 kg p_20_5 plus 25 kg k_20/ha in the northern and southern guinea savanna areas.

Weed Control

Weed control in groundnut is by the use of a hoe. The practice of ridging also aids in burying weeds. It is always advisable to weed at least twice after seedlings emergence.

Pest and Diseases

Although various pests commonly occur in groundnut crops, their populations rarely increase to harmful levels. Millipedes, nematodes and

thrips can occasionally cause damage. A serious problem in groundnut cultivation is the occurrence in large numbers of the aphid*, Aphis craccivora*, which is the vector of the groundnut. Rosette virus is a vector too with suggested control measures as; the planting of resistant varieties, planting early and at the recommended spacing, the destruction of volunteer plants which may harbor the vectors over the dry reason and rotation. Leaf spot disease cuased by *Cereospora spp* occur in warm humid weather. They can be controlled by seed dressing, early planting, rotation and good crop sanitation. Ground nut blight and bacterial wilt are controlled by crop rotation and good crop sanitation. Storage pests such as groundnut beetle and groundnut bruchid are controlled by keeping nuts in clean stores, prompt shipment and the use of insecticides. A Fungus, *Aspergillums flavus* causing aflatoxins occurs in humid conditions and enters the pods through cracks or termite holes. Careful harvesting to reduce pod damage and immediate drying are suggested control measures.

Harvesting and Storage

Planting is usually timed to ensure harvesting during a dry period soon after rains have ended but while the soil is still moist. Nut can be stored in the shell or after being sheltered. The preferred storage method is in the shell using lindane dust at the rate of 100g / 50kg of nuts to control storage pests.

YAM

Yams belong to the family *Discoreaceae* and the genus *Discorea.* This genus contains about 600 species out of which about ten are presently of economic importance. The genus is sub-divided into sections within which the species fall. Most of the economically important yam species are; *D. rotundata*, *D. alata*, *D. Cayenesis*, *D. opposita* and *D. japonica* are in yhesame section (Enantiophyllum), which is characterized by vines twining to the right (clockwise) when viewed from the ground upwards. Species in other sections are; *D. dumetorum* and *D. hispida*, *D. bulbifera*, *D. esculanta* and *D. trifida* twine to the left.

Common yams with origins of species

Botanical name	Area of Origin
D. rotundata	West Africa
D. cayenesis	West Africa
D. alata	South eastern Asia
D. esculenta	Iado China
D. bulbifera	Tropical Asia and West Africa
D. dumentorum	Tropical Africa

D. hispida	Tropical Asia
D. trifida	South America

Methods of Propagation

The yam plant can be propagated by tubers, bulbils, seed, vine cuttings or tissue culture. By far the most common and commercially viable method of cultivation is by tubers. The tuber pieces used for planting may be small whole tubers or tuber pieces derived from a large tuber sub-divided into small pieces, when such divisions are the setts, may be derived from the head, middle or tail regions of the tuber. The small whole tuber is the last planting material since it has a head region, enabling it to sprout readily and has no cut surface to make it prone to rotting. The setts from the head region produce the next best planting material followed by those from the tail and middle regions. It has been established that the greater the weight of the yam sett, the greater the resulting tuber. In commercial yam production, setts weighing 150-300 g should be used for planting. Even though larger setts may produce bigger yields per stand, the yield per unit weight of planting material tends to decrease as the weight of setts increases. For this reason, setts heaving than 300 g should not be used for cultivation of yam. Propagating yams by tuber means that as much as one-fifth of the yams produced in each season must be saved as planting material. This is a major limiting factor in the availability of planting material, the cost of which is rapidly becoming prohibitive. In order to overcome this problem, researchers have recently focused attention on the following techniques of rapidly producing seed material in abundance for farmers through;
The minisett technique involving the planting of pre-germinated tuber pieces ranging in weight from 45 g - 90 g directly into the field for seed yam production. The microsett technique involving 3-5 g pieces treated with phytohormones and germinated before planting.

Planting

Yams require a loose soil in which the tubers can grow easily. When a suitable site has been selected and the necessary land preparation made mounds, holes, hanks or ridges are prepared. In loose, deep sandy loam soils, yams may be planted on the flat. Plantings may either be in the dry season or at the onset of the rainy season. For dry season plantings, land preparation begins just before the rainy season ends and before the soil becomes dry and difficult to work on. The fresh yam setts are planted and they pass through a period of dormancy in the soil before they sprout. For rainy season planting, land preparation may be done at any time during the dry season. However, the yam setts are not planted until the rainy season begins. Such yam setts, because they

have been stored through the dry season will sprout readily, usually within a month after planting. Seed setts are cut into the appropriate sizes one to two days before the envisaged date of planting. The time interval allows the cut surface to heal over before the sett is placed in the ground. After the yam setts have been cut, they should be handled carefully to avoid damage and infection. Traditional farmers sometimes smear the cut surfaces with wood ash which appears to give some protection against rotting. Yams are generally planted at about 1m spacing in rows that are 1m apart. Wider or narrower spacings may be used depending on the set sizes. The bigger the yam sett, the wider the spacing. Spacing in traditional yam production is variable, depending on the extent of intercropping.

Fertilizer application

In general, yams respond well to nitrogen and potassium fertilizer, but show a slight response to phosphorus. For these reasons, many fertilizer recommendations tend to exclude phosphorus completely. Recommending 20: 0: 20 or ammonium sulfate only. On some soils, yams should be fertilized with a complete NPK fertilizer. The use of organic manures and composts is also recommended where they are available.

Weed Control

Yams are particularly sensitive to competition from weeds during the early part of their growth. Two to three months of weeding is necessary. Weeds are controlled by hoeing, which is done carefully to avoid any disturbance to the growing tubers. In general, the weed control recommendations for major yam growing areas in Nigeria are for hoeing 3, 8 and 16 weeks after planting and only light weeding thereafter.

Pests and Diseases

Yam beetle, termites, grasshoppers and aphids attack yam plants. Various species of nematodes attack growing yam tubers. Various fungal rots and mammals especially rodents can be serious pests of yams.

Harvesting and Storage

Two general practices exist with respect to harvesting. In the first, each plant in the field is harvested twice. This practice is termed double harvesting. The second approach is the single harvesting, which calls for harvesting of each plant once the season is over. In the practice of double harvesting, the farmer carefully digs all the soil around the tuber before the end of the season and removes the tuber, leaving the roots

intact. The roots are then retained to the ground and covered with soil. When the plant has been smeared at the end of the season, the second harvest is taken. The double and single methods of harvesting produce about the same yield. However, the farmer has the advantage of the produce of the first harvesting allows yam tubers to be in the market early, while the second harvest produces excellent planting material of good heeping quality. There are four main post-harvest storage methods for yams. These are barn, platform, underground and cold storage methods. The cold storage method calls for maintaining the temperature of the room at 15^0C. The use of air-condition in such rooms has been found to be effective since they reduce both temperature and humidity. This storage method is however expensive and its use in many yam growing areas in the tropics is limited.

MUSHROOM PRODUCTION FROM PLANT WASTES TO EDIBLE PROTEINS

Mushrooms are the members of higher fungi, belonging to the class Ascomycetes (e.g., Morchella, Tuber, etc) and basidiomycetes (e.g, Agaricus, Auricularia, Tremella, etc).They are characterized by having heterotropic mode of nutrition. According to Chang and Hayes (1978) edible mushroom refers to both epigeous and hypogeous fruiting bodies of macroscopic fungi that are already commercially cultivated or grown in half culture process or implemented under controlled conditions. They are rich in protein and constitute a valuable source of supplementary food. Some of them are deadly poisonous, for example *Amanita verna*, *A. virosa* etc. Although mushroom is a very nutritious food, it is a fungal plant in the scientific term. It is possible to be cultivated all the year round on Abuad farm. It also does not need large amount of space for cultivation. Only a little bit of open air is necessary. Maintenance of three times a day is enough. Mushroom production is a profitable sector. In the world 15 types of mushroom are cultivated at home and 5 types are cultivated in the field. On ABUAD farm, oyster mushroom and button mushroom are produced. Oyster mushroom is the most popular because it grows all the year round and so all over the markets this is available.

Importance of Mushroom

The enormous increase in our population has necessitated more and more food production through alternate sources for mushroom as the availability of more arable land for traditional crops is not likely to increase. Edible mushrooms occupy a pivotal position among the lower organisms. In the developed countries, mushrooms have become one of the most important of all the horticultural crops. The production of mushrooms is increasing everywhere in the world, and nowadays these

are available all the year round and are used in enormous quantities to serve all kinds of table dishes. There are about 5000 different species of mushrooms of which at least 1250 are reported to be edible. In 1980, about 800 million kilograms of *Hygracircus*, *Shiitake* and *Pleurotus* types of mushrooms were produced and consumed in the world.

Mushrooms are being used as food and medicine since time immemorial. Their cultivation on extensive scale can help solve many problems of global importance such as protein shortage, sustainable supply of protein and part of environmental management. Edible mushrooms contain a high percentage of protein, all indispensable amino acids, vitamins B-complex and other biochemical compounds. This vegetable is also a food source of dietary fibre and the quantity present is much higher than the crude fibre. The protein value of mushroom is double of cabbage, potatoes and asparagus, four times that of tomatoes and carrot and six times that of oranges.

The protein value of dried mushrooms has been found to be 30-40 per cent comprising all the essential amino acids. Mushrooms are sources of Niacin (0.3 g) and Riboflavin (0.4 mg). Mushroom is a good source of trypsin enzyme. It is also rich in iron, copper, calcium, potassium, vitamin D, and folic acid. Mushrooms are valuable health food, which are low in calories, high in vegetable proteins, zinc, chitin, fiber, vitamins and minerals. Mushrooms, also have a long history of use in traditional Chinese medicine to promote good health and vitality and increasing body's adaptive abilities. Specifically, selected strains of dried mushrooms are used to produce mushrooms capsules and extracts. The mushroom is a highly concentrated food and unsurpassed for flavour in addition to being a completely satisfying meal.

The edible mushroom mycelium (10-20 %) may be put in various sausages, minced meat and vegetables, soups, pastes and bakery products and many other dietary menus. Mushroom can be grown by anyone and anywhere. However, cultivation of this edible fungus also consumes agricultural and industrial wastes and produces products such as straw and molasses, which are excellent fertilizers and soil conditioners. Mushrooms have no coloring matter and so do not need sunlight to obtain the requisite nutrients for survival. They can grow in darkness, where no other crop would easily flourish.

Mushrooms are fleshy fungi, which are generally used as delicacy from time immemorial. It has no coloring matter or chlorophyll. It is tough with umbrella- like fruiting body. It produces microscopic spores, which serve

as a means of reproduction, but is not same as that of plant seed. Nowadays, mushroom is being relished throughout the world as food and medicine. Researchers reports revealed that mushrooms are rich in food values being food source, and out of 100 g, it contains proteins (3.6 g), minerals vitamins B,12 (0.26 mg), fats (0.3 g), carbohydrates (1.5 g), dietary fibers (2.5 g) and ash (5.0 g) and the vitamin contains are exceptionally high. The protein contents are significantly higher than those provided by other foodstuffs like dates, potatoes, lettuce, carrots. Dried mushrooms contain more proteins than beet. They also contain folic acid, which is blood- building vitamin and counteracts the pernicious anemia with its properties. They serve as possible sources of antibiotics and anti-cancer agents. They lower the cholesterol level of blood pressure. Mushrooms constitute an ideal source for reducing body weight.

Advantages of Mushroom Cultivation

1. No need of cultivation land
2. Can be cultivated inside homes
3. Can be cultivated in rack
4. In a short period (7-10 days) mushroom can be found that is impossible for any other crops

Economic Benefits Mushroom Cultivation

1. Very few money is required.
2. The invested money can be returned in a short time.
3. Working time is low.

Social Benefits of Mushroom Cultivation

1. Malnutrition can be removed
2. Disease costs are decreased
3. Incensement of production ability
4. Unemployment problem is removed.

Environmental Benefits of Mushroom Cultivation

All of the vegetables that we eat daily are cultivated by using chemical fertilizers and pesticides that are very harmful to the environment, but there are no pesticides and fertilizers required for mushroom cultivation.
The components that are used for mushroom cultivation are waste products. Substrates that can be used as growing medium include:
the straw and leaves of wheat, paddy, barley, oat and grow straw, banana, sugarcane and maize, empty millet heads and corn cobs, cotton wastes, thin sticks and sugarcane bagasse, saw dust, dust logs, straw papers, manure, etc.

Steps in Growing Mushroom in ABUAD

Step 1: Purchase of mushroom seed: The Mushroom seed which is of high-quality is being ordered from Cotonou.

Step 2: Sterilize the growing medium. The growing medium (sawdust, rice husk, corn cob e.t.c.) used is being sterilized, it is necessary to sterilize these growing mediums before inoculating with the seeds. This is done to kill off any micro-organisms that could compete with the mycelia. To sterilize the growing medium, it is being filled into a white polypropylene bag and enough water is added to make the straw or sawdust damp which is then tied with rubber band, after which it is then placed in boiling water and heated for about 8hrs until the water has boiled off. This kills off any microorganism present in the medium, leaving the growing medium safe to receive the mushroom seeds.

Step 3: Inoculation (planting). After sterilization, sterile polyethylene bags filled with the compost are inoculated with the mushroom seeds under aseptic conditions. High seed rate used is done to discourage contaminants and pests.

Step 4: Incubation. After this, the set up is placed in the dark room for 4 days, this will allow the mushroom seed to permeate the growing medium. Good ventilation supplies a constant flow of fresh air and prevents carbon dioxide build-up. The shelves are arranged in a way to allow ease of air circulation. Metabolic heat from the seeds will raise the temperature of the compost and it may require cooling. There is an air-conditioner provided here to regulate and maintain constant temperature and humidity in order to produce high-quality mushrooms. The surface is kept moist and cool, which is checked periodically and sprayed with water as necessary.

A cross-section of growing medium arranged in the dark room.

Step 5: Fructification. To initiate fructification, the medium is well aerated, moistened, cooled and illuminated. The medium is therefore perforated and then moved from bright light to shaded area and hanged on a row. They start coming out through the perforated points and within the space of two hours, they blossom fully.

A cross section of growing medium hanged on a row.

A cross-section of blossomed mushroom.

Harvesting

The mushroom flushes every day. Harvesting usually commences at the first sight of buttons. The fruiting bodies are harvested by hand with a twisting motion so that stubs or left-overs which may cause die-back or infection are not left behind, and young mushroom are not disturbed. The stems are trimmed and the mushrooms are graded and packed clean into plates covered with un-perforated polythene for sale.

Packed mushroom ready for sale

CHAPTER II: LIVESTOCK PRODUCTION/ANIMAL HUSBANDARY

PIG PRODUCTION

The keeping of pigs for meat production in Afe Babalola University started in June 2013. The pig farm began with only three breeds of pig: large white, land race and duroc. These breeds have been crossed to give rise to better offspring. Mostly, the sows farrowed about 8 piglets per parturition. They are mostly raised on concentrate i.e. formulated diets and forages/roughages.

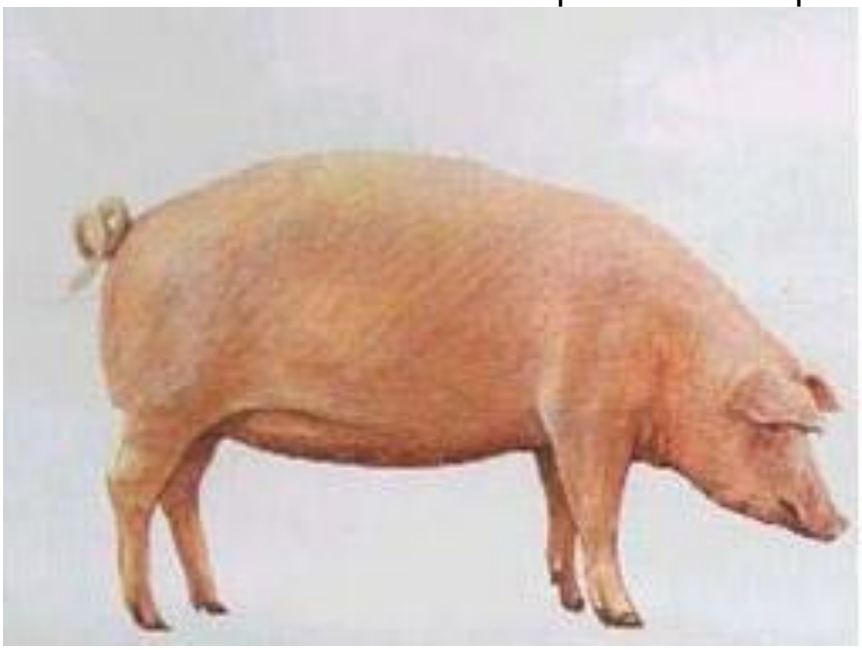
There are mainly three breeds of pigs in Afe Babalola University which are:

Large white: They are distinguished by their erect ears and slightly dished faces. They are long bodied with excellent hams and fine white hair. Very prolific, late maturing with good mothering ability. Fairly hardy animal. They are extensively used for crossing with other breeds for bacon production and grading up of poor herds.

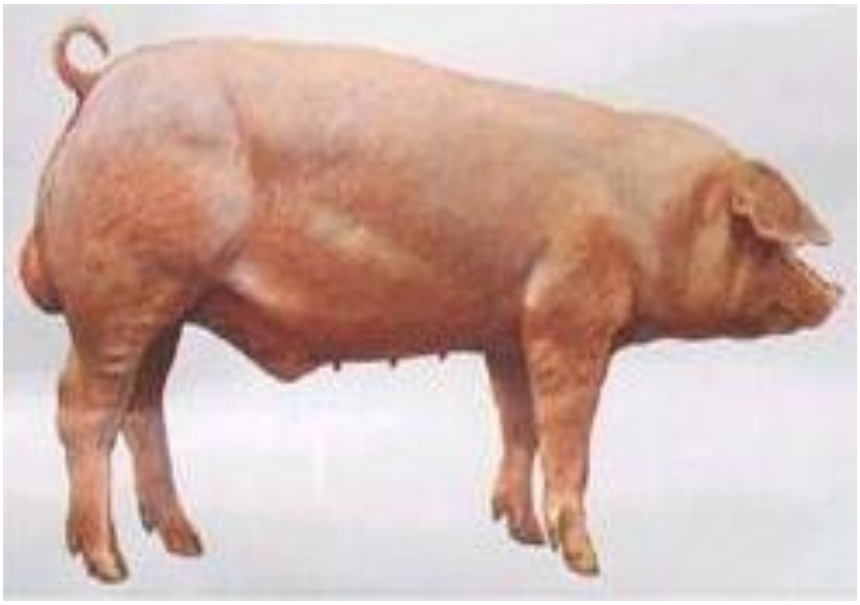
Large white sow

Large white boar

Land race: It is a very versatile breed. They perform well under good management. They are white in color, They possess large dropping ears and a straight snout. They have the longest body size. Sows produce and rear large litters of piglets with very good daily gain (ADG). They have high lean meat content ideal for either pork or bacon production.



Land race sow



Land race boar

Duroc: Their coat colour is Golden brown to black. They possess thick auburn coat and hard skin. Have small slightly drooping ears and arc back. They are known to have quick growth, deep body, broad ham and shoulder. They are very docile. An outstanding trait in the Duroc is its hardiness and resistance to stress, which results in lower levels of mortality.

Duroc sow

Duroc boar

Pigs Housing Facilities

The housing facility provided for pigs in Afe Babalola University is the open sided house. At the entrance of the pig house, there is a dip bath in which water and disinfectant are provided. The house is built such that heat can be easily gotten rid off from the house. This is very crucial in that pigs lack sweat glands thereby, environmental heat added to metabolic heat will cause a lot of discomfort (heat stress) for the animal. The house is divided into pens and the pigs are housed in individual pens. The pens have inbuilt water and feed troughs. The pens are built in such a way that makes room for easy washing away of urine and feaces defecated by the pigs.

Pigs housing

Pig Management

Daily Routine Operations:

The following operations are firmly adhered to in ABUAD pig farm. And the recommended sequence is as follows:

1. Water should be provided first in the morning
2. Water should not be added to the left over in the trough.
3. The water trough should be thoroughly cleaned and refilled with clean fresh water.

Feeding:

Feeding is done twice daily, morning and evening. Concentrate is fed to the pigs while forages/roughages are fed when available.

Cleaning:

It is done after the watering, feeding and allowing the pigs to defecate
Manures are removed from the pens. If a pen is vacated it is washed and disinfected before bringing in other animals.

Observation of every animal each day:

This is done to check on the state of health. This is done to ascertain lack of parasite, to check for heat period, injuries. To establish general comfort of the pigs.

Breeding Operations and Management

In breeding/production of pigs, basic/fundamental principle and guiding rules should be put in place, they are:

Source and choice of breeds

The introduction of diseased stock poses the biggest threat to the herd's current health status. Pigs should only be brought in from known healthy herds, and where possible some guarantee obtained as to their freedom from certain diseases, or parasites. A period of quarantine (4–6 weeks) and acclimatization provides insurance against new diseases being introduced and allows new pigs to be exposed and gain immunity to diseases in the new area. Large white is robust, adaptable and of higher performance than others breeds. Duroc - Jersey also has good attributes for both rearing and growth in the tropics. Landrace pigs have been widely used for crossbreeding purposes in the tropics. They do well under close confinement feeding but must be well managed and fed.

Selection of Breeding Gilts

One of the greatest effects on profitability is the number of piglets reared per sow per year. As well as possessing the genetic potential to improve the production characteristics of her progeny, the sow must have the ability to rear large, healthy litters. Gilts selected to have at least 6 evenly space teats on both sides so as to accommodate a large litter. Avoid selecting gilts with blind teats. Short, thick teats are less desirable than longer thinner teats. It should be large, without sign of infantilism, and free of the 'fish hook' appearance found in hermaphrodites. Gilts selected from sows, which weaned 9 -10 or more piglets per litter and are known to be good mothers. Select breeding gilts at weaning period, further selection should be done 5-6 months of age. Select fast growing weaners. These will likely consume less feed per unit live weight gain. Thus less costly to keep. Select gilts which have developed hams and comparatively light heads. The selected gilts should have good body confirmation i.e. strong legs, sound feet etc. Gilts should be wide through the hindquarters with depth and squareness in the body cavity. If the physical soundness of the gilt is in doubt she should not be kept as a breeder. Gilts should be quiet but alert and active. If there is any tendency to be flighty or overly aggressive, they should be disregarded as future breeders.

Selection of Breeding Boars

It is extremely important to select a good boar since it contributes half the quality of the herd. Boar should have sound feet with good, full hams, uniform curve at the back and of good length. Boar should have at least 12 nicely placed rudimentary teats so as to pass on this characteristic. Selection to be done before castration i.e. at 4 weeks. Make sure that his toes and pasterns are not long, weak or misshapen. The boar should walk freely, without any sign of stiffness or lameness.
The testes should be normal in shape and size, even, and free from defects

Types of Breeding

Here are the two major types of breeding systems used in pig production at ABUAD:

Pure-breeding

Mating purebred individuals of the same breed. The progeny has the same genetic makeup. Objective of pure-breeding is to identify and propagate superior genes for use in commercial production. To propagate and identify superior females for maintaining valuable genetic material.

Cross breeding
Mating two individuals from different breeds. Take advantage of the observed improvement in performance of the progeny above that of either parents - heterosis.

Breeding cycle
The normal heat period lasts for 3 - 5 days

Heat signs:
1st stage: Early heat signs.

1. General restlessness
2. Vulva turns red and is swollen
3. White mucus discharge

2nd stage: Service period signs

1. Real Oestrus lasts for 40 - 60 hours
2. Vulva becomes less red and swollen
3. Slimy mucus discharge
4. Tendency to mount and be mounted by others.
5. The sow or gilt will stand still when pressure is applied to her back. (Thus the right stage to send her to the boar or inseminate).

3rd stage: *Post oestrus*-period signs

1. The sow/gilt will not stand still when pressure is applied to her back.
2. The swelling of the vulva disappears.

About two weeks before servicing the sow, it should be flushed (feeding extra feed to increase the ova shed in order to increase the number of foetus). After servicing the gilt/sow at the second stage of heat and no sign of coming back on heat is noticed, then, animal is pregnant (gravid). Steaming up of gravid sow is carried out by increasing the feed at the last trimester.

Expected date of birth
It takes about 3 months, 3 weeks and 3 days for a pregnant sow/gilt to farrow.

Preparations against farrowing
About a week before the expected delivery date, the sow is washed with soap and water and then rinsed with a mild disinfectant. The pen is

disinfected before the pregnant sow is put inside the pen. Immediately after washing, the sow is placed in a farrowing pen.

Dewormed and treated for lice and mange
2 days before farrowing, the sow and the pen is washed and disinfected again.

Signs of Farrowing

1. Udder enlargement during the last 2 days.
2. The udder will start to look much redden.
3. A white or clear fluid can now be extracted from some of the teats.
4. The sow will be livelier, alert, restless and may start to bite.
5. It scrapes the floor with her forefeet and sweeps the straw bedding into a corner with her snout to make a nest.
6. In group housing the sow may fight other sows.
7. Just before delivery, the udder will swell and the sow will calm down.
8. Before the first piglet is born a bloodstained fluid comes out of the vagina. In gilts the fluid may be released earlier.
9. The sow will usually farrow during the night or evening.

Piglet Management

1. A few minutes after the birth the umbilical cord may be pulled gently away or cut if necessary (to about 5 cm length).
2. After birth, the navel of each piglet is dipped in a cup of iodine solution to prevent inflammation and tetanus.
3. Each piglet is rubbed dried with a clean cloth.
4. The piglets are made to suck from the udder as soon as possible after birth.
5. The piglets can be given additional feed of cow's milk, or a mashed bean porridge to which a little sugar has been added.
6. If the milk produced by the sow is too little to meet the needs of the piglets or the sow completely neglects the piglets, they are usually transferred to a foster mother or reared on cow's milk.

Weaned piglets in their pen.

Iron Deficiency in Piglet

This is an important problem, especially for young piglets kept indoors. They receive additional 1-2 mg/day from milk while they need 7mg during the first week. The piglets become very pale a few weeks after birth and their growth slows down.

This is prevented by:

1. Giving the piglet (0-3 days after birth) iron injection preferably at neck muscles
2. Oral iron- paste containing iron is put in the mouth within 24 hours of birth
3. Feeding compost- that is of good quality can be supplied daily. Compost of poor quality may contain bacteria.

TURKEY PRODUCTION

Turkey rearing in Nigeria is well exploited probably due to the fact that it puts on weight rapidly and well appreciated as gift at Christmas and other festive periods. Afe Babalola University is also into turkey production. The breed being reared in ABUAD farm is white Holland.

White Holland Breed

Purebred White Holland male turkeys usually weigh about 15kg, and females weigh around 8.17kg. The White Holland turkey has snow white feathers and a red to bluish head. Some male White Holland Turkeys have black beards. The beak is pink to horn colored; and the throat and wattles are pinkish-white. Shanks and toes are pinkish-white. The original White Holland Turkey had blue eyes, though today many White Holland varieties, crossed with colored turkeys for greater hardiness, have brown eyes. Today, some varieties of White Holland Turkeys that have been crossed with Large Whites have broader breasts and shorter legs than the original, rare variety.

Housing

Turkeys can be kept on free range due to the fact that they are very hardy. Although, there is a greater risk of disease and theft with free ranging. Also, turkeys should not be kept on ground previously used by other poultry birds. When siting their house, a damp, poorly drained soil

should be avoided due to Blackhead disease. Dry chalky soil is the best for rearing turkey.

A Typical turkey House

Trees should be plant around the house to serve as shade and wind breaker. However, in Afe Babalola University, turkeys are raised in poultry houses. They are housed in open sided house that are covered with wire mesh. At the entrance, there is a deep bath to which water and disinfectant had been added. Everyone entering the house must dip his or her feet it, into the bath to avoid transmission of diseases into the flock.

Feeding

In the turkey house, hanging feeders and drinkers are used to avoid contamination through scratching of litters into the feed. The water system is automated. The turkeys were offered starter when they were poults (for 4 weeks) and finisher ration thereafter till maturity. The maturity of turkey is guided by weigh and breed. Heavy breed matures at about 24 weeks at a market weight of about 15 kg while the medium matures at 16 weeks at a weight of 7 kg and small strains attain maturity at 12 weeks having 4 kg.

GEESE PRODUCTION

Geese are usually good foragers and grazers but they do well where there is enough space. They are generally noisy and in fact, they are sometimes used as watchdogs. The breed of geese at Afe Babalola University farm is the white Chinese geese.

Chinese Geese
These are said to have originated from the wild geese of China. They are graceful and swan-like in appearance and are either white or brown. They are excellent foragers and lay more eggs than any other breed. The flesh is excellent for the table- it is darker than other breeds and less greasy. The birds are ready for killing from 8 weeks of age.

Housing
A pen was provided for the goose but it is reared on semi-intensive system. It is allowed to go around the farm in order to graze and exercise itself. Being a waterfowl bird, it has access to water while walking round the farm.

Feeding
Feed is being compounded for the goose at the feed mill and it is allowed to graze on the surrounding forages around the farm. Water is provided on a daily basis in its pen.


A flock of Geese

DUCK PRODUCTION
Ducks are known to originate from the wild Mallard except the Muscovy. Ducks outlay hens. They are also known for laying bigger eggs than hens. A duck will continue laying for a longer period than a hen. Ducks are less susceptible than hen to some poultry diseases and indeed, are immune to a few of them. They are however, acknowledged to eat more and tend to be messier than hens. However, they are good scavengers and swimmers. Though they are scavengers, they are less destructive in gardens than hens.

Duck Breeding

Breed
The breed of duck being raised in ABUAD was imported from Ghana.

Feeding
Ducks are offered formulated feed in their pen. A duck will usually eat 170-200 g of feed per day. They are fed twice in a day (morning and evening). Cool and clean water is also made available to the ducks.

Housing
The ducks are raised on intensive system of production. They are housed in their pen. On the floor of the pen, wood shaving is spread to mop up the droppings and serve as bedding material. The duck house is an open sided house built with high wall and net was used to cover up the open area. This will prevent the ducks from flying away.

QUAIL PRODUCTION
Quails are smaller sized birds, so they can be raised within small place. Due to their small body, cost of feed is comparatively lower than chickens or other poultry birds. Diseases are less in quails and they are very hardy hence, the quail business is less risky. They grow faster than other poultry birds. An adult quail weighs between 150-200 g and an egg weighs 7-15 g. They start to lay as from 6-7 weeks of age. A quail can lay up to 300 eggs in a year. The fertile egg takes about 16-18 days to hatch but quails do not incubate their eggs. Both meat and egg of quail

are very tasty, delicious and nutritious. Quail farming business requires small capital and very low labour cost. Quail meat contains less fat hence; it is suitable for high blood pressure patients. The space required for raising one chicken will conveniently be used for rearing 6-7 quails. Japanese quail is reared in Afe Babalola University farm for both meat and egg purposes. They are kept on deep litter system.

Life Cycle of Quail

Quails generally survive for 3-4 years. They grow faster than other poultry birds. An adult quail weighs between 150-200 g and an egg weighs 7-15 g. They start to lay as from 6-7 weeks of age. A newly born quail weighs around 6-7 g. The mating ratio of male to female should not exceed 1:5. Quails become very sensitive at about 2 weeks of age.
In setting a quail business, there are important issues to be considered:

Breed selection

There are about 20 species of quail available and suitable for profitable quail farming business. Some of them are known to be good egg layers while others are popular for meat production. Depending on the interest of the farmer, selection can be based on production focus.

Housing

Housing is very important in quail farming because they are flighty birds. Inadequate housing can lead to the loss of all the quail in the farm. Quail can be raised in deep litter system or cage. In Afe Babalola University farm, quails are reared on the deep litter system. Wire net is used to demarcate and cover the open sides. This will prevent predators and flying away of the birds as well as provision of good lighting of the house. Wood shaving is used as their bedding material. They lay their eggs on the floor and the farm workers collect and sell the eggs.

Quail House

Feeding

Quail have a high-protein requirement, 30 % for the first week of life, 20 % from the 4th week is adequate. Turkey starter feed that is medicated can serve as starter feed for quail chicks followed by a grower-type feed. Since the turkey feed is too big for quail chicks, it should be smashed to smaller size for the quail. Also provide water for the quail *ad-libtum*. After about four weeks, add flight conditioner to the chicks' feed. An adult quail will consume 20-25 g of feed daily.

Raising Quail Chicks

Quails never incubate the eggs. Their eggs are incubated artificially; either by an incubator or including their eggs in that of a brooding hen. After hatching, the following are very essential for the chicks' survival:

1. Adequate temperature
2. Sufficient light
3. Proper air movement
4. Density of quail chicks
5. Supply of feed and water
6. Hygienic rearing rules

Diseases

Disease incidence is less pronounced in quail birds compared to other poultry birds. However, this can be better attained with good care and proper management to keep them free from all types of diseases and illness. Generally, quails are not giving any disease preventive vaccines; however, they cannot tolerate weather change and sudden temperature change.

Hygienic Quail Farming Tips

1. Always keep their house dry and clean
2. Ensure proper movement of light and air inside their house
3. Keep different ages of quail separated from each other
4. Cull/separate the diseased quail from the healthy ones
5. Burn or bury the dead bird
6. Do not allow other birds, animals or unknown persons enter the quail house.
7. Ensure hygienic and balanced feed supply
8. Provide adequate fresh and clean water

Guinea Fowl Production

Guinea fowl, often referred to as guineas, are game birds that are increasingly popular among keepers of small and backyard flocks. Guineas are vigorous, hardy, and largely disease-free birds. There are many reasons people raise guinea fowl. The birds sound an alarm whenever anything unusual occurs on the farm. While some people find this noise to be a nuisance, others find it to be an effective tool for protecting the farm and make guinea fowl the farmyard "watch dogs." The loud noise of the guineas has also been shown to discourage rodents from invading the area. Keeping guinea fowl is also an effective means of pest control. Flocks of guineas kill and eat mice and small rats. In addition, guinea fowl can be used to control insects. Wild guineas eat mainly insects, and domestic guineas can consume large amounts of insects without affecting garden vegetables or flowers. Guineas have been used to control wood ticks and insects such as grasshoppers, flies, and crickets. Guineas can reduce keepers' risk of Lyme disease by consuming deer ticks, which carry the disease. Guinea fowl also eat slugs, and flocks have been known to attack snakes.

Guinea fowl can also be raised for meat and egg production. The meat of young guineas is tender and tastes like that of wild game. The meat is lean and rich in essential amino acids. Guinea eggs can be eaten just like chicken eggs (and should be collected daily if not used for hatching

purposes). During the laying season, it is common for a guinea hen—an adult female at least one year old—to produce an egg a day. There are three main varieties of guinea fowl raised: pearl, white, and lavender. The pearl variety is the most popular and typically the one that people recognize most readily. Feathers from the pearl variety are often used for ornamental purposes.

Guinea fowl

Housing

Guinea fowls are often left to fend for themselves, but it is best to provide a shelter to protect them from high winds, rain, cold, sun, and predators. The shelter can be a purpose-built facility specifically for guineas or a room allocated in the barn. At Afe Babalola University, the guinea fowls are kept in covered pen. The floor of the pen is covered with an absorbent bedding material; wood shavings. If the litter is kept dry, it can stay in place for several months. Guineas prefer to roost, so it is important to provide perches. If the barn is unheated, it is best not to insulate the shelter or space where the guineas are kept. Insulation tends to keep moisture in guineas more than they keep cold outside, and allowing moisture to accumulate in a poultry house can lead to respiratory problems among birds. Guineas are able to fly at a very early age, and they become strong fliers able to fly 400 to 500 ft. at a time. Guineas are also very good runners and prefer to move on foot, including when escaping from predators.

Under most conditions, you should not confine male guineas with chickens if there are roosters in the same flock. When male guineas are housed with roosters full-time, the guineas will chase the roosters, keeping them from food and water. It is also safe to house them together

in a short-term emergency such as a blizzard or other bad weather. If guineas are kept for egg production, you should provide nest boxes. Nest boxes designed for chickens are usually acceptable. To reduce the likelihood of hens laying eggs in hidden nests outside, keep guinea hens confined to a hen house until noon each day so that they will lay eggs inside. In ABUAD, they are intensively cared for; they are not allowed to roam about.

Guinea fowls house

Nutrition

Adult guineas forage for themselves and are able to meet most of their nutrition requirements on their own. They consume a variety of insects and arachnids (mosquitoes, ticks, beetles, and so on), weed seeds, slugs, worms, and caterpillars. Guineas need to consume some greens in order to maintain good digestion, and so they eat grass, dandelions, weeds, and other vegetation. Because the birds are consuming vegetation, it is important to make sure grit is available for the birds, and the birds also benefit from having oyster shell available. Provide clean water at all times. Guineas do enjoy a little scratch feed on the ground. They like wheat, sorghum, or millet grain and will ignore whole corn kernels. If you are keeping the guineas for pest control, restricting their feed will encourage them to spend more time eating insects. If for any

reason guinea fowls are not allowed to forage, they can be fed with a commercial poultry diet. It is important to use a non-medicated feed. Guineas need a higher protein feed than chickens, but do quite well on regular poultry diets. Keets need a 24% to 26% protein ration as the starter feed. The protein level should be reduced to 18% to 20% for the fifth to eighth weeks. After eight weeks, the keets can be fed a 16% layer mash. If your feed mill does not sell feeds in the proper protein levels, you can mix a higher protein feed with a laying-hen mash to get the proper protein level. Guineas should be fed mash or crumbles. Pelleted feed is not recommended for guineas. You should also provide supplemental greens, such as leafy vegetables, for the guineas to peck. They will eat the leaves. It is important to remove any leftovers daily. Compounded feed is giving to guinea fowls in ABUAD farm.

CHICKEN FARMING

Table eggs and meat production from chicken are among the veritable means of wealth creations in Nigeria. Although chicken farming is becoming more and more capital intensive, experiences have shown that it has quick returns on investment than most other agric-business enterprises. The income begins to flow within 10 to 12 weeks for broilers, or 22 to 24 weeks for layers. A chicken farm of any size may be established, depending on farmer's financial strength, his expertise as well as his production targets. Success in chicken farming is however not automatic, as the risks involved could be very high, especially for the inexperienced. Good husbandry and management are *sin qua non* to profitable production. Good management demands that the farmer has a wide knowledge of housing, feeding, disease control and general chicken welfare at different stages of growth. The discussions here are some of the essential management procedures for successful chicken farming operations

Management of Young Chicks

Chicken farmers procure their chicks from commercial hatcheries which specialize in intensive production of hybrid pullet or broiler chicken. Most farmers buy their flock as day old chicks. Young chicks must be brooded from a day old to about 4 weeks of age. Brooding period is perhaps the most critical time in bird's lives during which there could be more death than in the entire lifetime of the flock. Starting brooding with healthy day old chicks helps to reduce the chance of disease occurrence. It is essential to provide proper growing condition for the chicks. Before the day old chicks are received, the brood house must be prepared. If the house has been used before, the old litter should be removed, and the

floor, walls and roof thoroughly cleansed and disinfected. The house should be left to dry for some days. New litter of at least 5 cm should be spread on the entire floor for a start and the depth may be built up after a few days. The litter should be clean and dry. Wood shavings are mostly preferable as litter materials, although materials such as saw dust may be used. Strict sanitation measures must be undertaken during brooding to reduce the number of pathogens as far as possible within the environment thereby reducing the potential exposure of the flock to disease. Vaccination is very essential.

Housing

Brood house should be well ventilated to ensure steady supply of fish air to the chicks. The house should have 1 m^2 window space for each 10m^2 of floor space. Avoid draught across the chicks, particularly at night. Allow enough floor space for the chicks to move about, eat and drink freely. This is necessary because too little or too much floor space can adversely affect growth and efficiency of production. If the space is insufficient, young chicks have difficulty finding adequate feed and water, which can result in feather picking and actual cannibalism. If the space is too much, it can cause the chicks to become bored, which can lead to problems similar to those caused by overcrowding.

Floor space and equipment requirements in brood house.

Number of chicks	Brood space (m^2)	Drinkers	Feeders
50	1/2	2 – 3	2 – 3
50 – 100	1	3 – 4	3 – 4
100 – 200	2	4 – 5	4 – 5

Temperature

The incubator temperature is 37 ^{0}C at hatching and needs to be maintained but reduce gradually during brooding. The temperature should be 33 to 35 ^{0}C on the first day, 30 ^{0}C on the seventh day, 28 ^{0}C on the eleventh day and 24 to 25^{0}C after two weeks. Lower temperature is needed by the chicks to grow feather. The temperature should be decreased further and the source of heat removed on a warm day after the first week. In order to achieve the recommended temperature for the chicks especially during the first week, there may be need for confinement around the source of heat, using a brood guard. The chicks should spread evenly around heat source, which indicate adequate heat in the brood.

Protein requirements in chicken.

Chicken	Age (week)	Percentage of protein required in diet
Broilers	0 – 4	20.0 – 23.0
Broilers	4 – 10	
Pullets	0 – 14	15.0 – 18.0
Pullets	14 – 20	12.0
Layers		14.5

Chicks during booding

Lighting

Eating must be stimulated especially at the beginning of the brooding period. The chicks will eat when there is light, so artificial lighting must be provided in the night. The light will be reduced gradually as the chicks grow.

Chicks age and lighting period

Age of chicks (week)	Period of lighting (hour)
0 – 1	23
1 – 2	20
2 – 4	16

Feeding and watering

Chicken mash is used in feeding young chicks. The mash should be purchased from a reliable feed manufacturer and kept in a cool dry place, away from rodents. On the first day, the feeder should be filled to the top and the feed sprinkled on the chick boxes. This is done to attract the chicks to the feed. After the chicks have learnt and accustomed to the feed, feed wastage can be minimized by keeping the feeders less than half and replenishing regularly. Feeders and water troughs should be distributed evenly in the brood house to allow each chick to have access to them. Chicks should quickly learn how to drink water to prevent early dehydration and mortality. They can be taught by dipping their beaks into the water as they are placed on the litter. It is important to note that, for the first few days of brooding, heating and water are more important to chicks that feeding.

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Management of Growers

Pullets from eight to twenty weeks old are regarded as growers. The rearing period is the time interval between the end of brooding and the point-of-lay when the birds are fully mature for egg production. Management of pullets at this stage is quite different from managing young chicks. This stage is very critical in the life of the birds and any practice adopted at this period could have a major role in determining the success or otherwise of the entire production. The aim of the farmers must be to ensure satisfactory development during this period. Most commercial farmers adopt confinement rearing

Broilers under culture.

Cockerel under culture

SNAIL PRODUCTION

Snail farming in Nigeria is now one of the most lucrative businesses that one can embark upon; either on a small or large scale, with very low initial capital outlay. Snails are very prolific breeders and they can reproduce very fast. There is a growing need to meet the increasing demand for snails, especially as demand for snails is on the increase. The traditional method of raiding the forest and woods to gather snails to sell is no longer a reliable means for anyone serious in this business to be able to meet the growing demand for snails. Each adult snail can produce up to 600 snails each growing season. Hence, within a very short while, the farm can quadruple its initial size. It is easy to manage, requires little attention, large numbers can be reared in a small space within residential house without any repelling odour. Not only is snail meat a local delicacy but snail meat and its shell are export products and huge foreign exchange earners. Snail meat is high in protein (12-16 %) and irons (45-50 mg/kg), low in fat, and contains almost all the amino acids needed by humans. It is also very high in vitamin A, calcium and magnesium. A recent study has shown that the glandular substances in edible snail meat could be of value in fighting a variety of ailments, including whooping cough. Snails can also be helpful to Asthmatic patients. It has also been recommended for the aged and hypertensive patients. Snails are hermaphroditic in nature. This means that each snail has both the male and female reproductive organs. As a result of this, they reproduce rapidly, so there will not be any need for you to replenish stock. One snail can lay about 80 to 100 eggs 6 times a year. Snail meat is better than red meat – As snail meat is low in fat, sodium and cholesterol, and high in protein, iron, calcium and phosphorus content, doctors and dieticians are forever recommending it to their patients and the public. In Afe Babalola University farm, snails are raised in an unusual way.

Snail

Steps for Starting Snail Farm

In starting the snail farm at Afe Babalola University, the following processes were undergone in a step by step process.

Suitable Environment for Snail Farming

Generally, snails are easily dehydrated. Dryness occurs in snails due to moisture loose in snail. Dry wind increases the rate of moisture loose in snails. Hence, a suitable location for snail farm was cited for the establishment on the farm. This will help to prevent the snails from losing water from their body quickly. An area with many trees can make a perfect environment for rearing snails. In ABUAD, the snail house is covered with net and a palm-front shed is built right inside the snail house. This makes the environment extremely cool and perfect for snail production. Water sources for sprinkling on the snail are also installed in the snailery.

Suitable Soil for Snail Farm

Soil is the main habitat of snail. For successful snail farming, the selected land for this business must contain some of the components and chemical substances which are necessary for the survival of the snails. For this reason, all types of soil are not suitable for commercial snail farming. The shell of the snail is mainly calcium and they derive most of the calcium from the soil. They drink water from the soil and also lay eggs in the soil. The soil must contain all the essential minerals to ensure the optimum performance of the snails. Soil for snail production must never be waterlogged, too dry nor be too acidic. Always avoid the clayey and acidic soil. In ABUAD snailery, sandy-loamy soil with low water holding capacity is used. It looks like the humus soil that is dark-brown in color. It is a loose soil that the snail can easily burrow into and lay their eggs. Before stocking, the soil must be sterilized to get rid of harmful microbes.

Getting the breeder stock

Getting the right breeds for snail production is very essential and crucial. Continuity and profitability of the business hang on this. Some snail farming expert said that, getting snails directly from the forest (from the wild) instead of purchasing from market had better result in production. The snails from the wild can easily adapt themselves to the new environment than the snails from another farm. If it is difficult to collect snails from forest, snail can be collected from the bush through a very simple technique. During rainy season, clear a little portion of land and sprinkle spicy fruits there like banana, pawpaw, plantain or pineapple.

Suppose this was done at 5 pm in the evening. Then go back there after 2 or 3 hours. Collect all the snails gathered in the place. Repeat the process until you get sufficient amount of snails for your farm. There is another way of getting good breeding stock for your snail farm. Pick/collect some snail eggs littered in the market where it is sold. While collecting, check the fertility of the eggs, because eggs loose fertility because of their exposure to sunlight. Then put the eggs inside a container containing wet sand and cover with cocoyam leaf. Within 21-28 days those eggs would hatch into baby snails. Start feeding the baby snails. Gradually they will grow up and then they can become the breeder stock.

Snailery (Small Snail House)

Snailery is very essential for snail farming, a good snailery keeps the snails safe and productive. In case of breeding in small scale, snaileries can vary from a patch of fence-protected ground, sheltered from the wind to a covered box. Make a concrete pen with soil deep of about 10 inches or dig a trench, and cover it with screen or wire all around to prevent the snails from escaping for larger and commercial production. Generally, snails love to stay in cold and dark place but keep the snails free from harmful humidity level. For regulating the temperature, fresh leaves and cloth that is regularly wet can be used. Prevent entrance of harmful animals like snakes, rats and some other harmful predators. Wire is a great solution for keeping those animals away. Also do not allow harmful insects like termites and solider ants into the snail house.

Feeding

Snails generally eat fruits, green leaves etc. Food ensures the proper growth of snails. Provided food helps the snails grow their tissues and calcium for growing shells. You can feed your snails with some leaves like cassava leaves, cabbage, cocoyam, eggplant leaves, lettuce leaves, okra leaves or pawpaw leaves. Among the fruits you can feed them, banana, cucumber, eggplant, mango, oil palm fruits, pears, pawpaw, tomatoes etc., produce good snails. In ABUAD, the snails are made to feel as if they are in the forest in that, various crops cherished by these snails are planted in their house. They have unlimited access to these plant fresh at any given time. The plants planted in the house of the snail are: cocoyam, banana, water leaf, pawpaw etc.

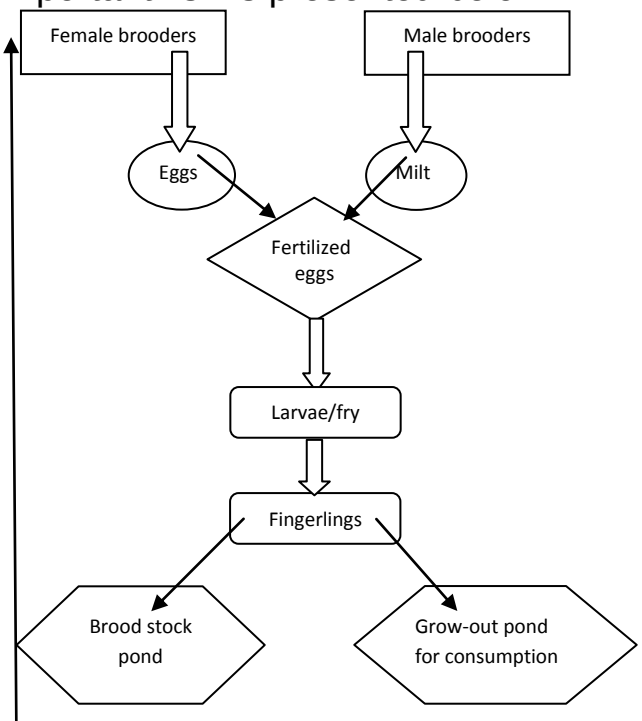
CHAPTER III: FISH PRODUCTION

FISH PRODUCTION

The aquaculture industry in Nigeria is gradually metamorphosing from the traditional government-owned demonstration units into a more viable, private-driven economic activity. Once regarded as a part-time leisure activity or hobby, fish farming is now considered as a profitable enterprise with enormous potentials for addressing national food security and creating job opportunities for our teeming population. According to reports, the national annual domestic fish production from aquaculture has risen from 20,000 metric tonnes in year 2002 to over 250,000 metric tonnes in 2013. Despite this growth, the gap between the supply and demand for fish is increasingly widening every year owing to the increase in national population. New entrants must therefore be encouraged involve in fish farming so as to meet this demand and thereby create wealth for themselves.

Fish Farming Practice

Two species of fishes, *Clariid catfishes* and tilapia, are mainly cultured in Nigeria. There is high preference for farming catfish rather than tilapia because catfish commands higher market prices and consumers' preference. The discussion here is directed primarily at hatchery production of catfish fingerlings as well as pond culture of table size fish meant for human consumption. The flow chart of the production cycle of this commercially important fish is presented below.



Flow chart for catfish production cycle

Hatchery Management

Broodstock selection

Good qualities (fast growth, high survival rate, low food conversion rate, tolerance to crowding, etc.) in fish are, among other factors, genetically determined. Therefore, farmer cannot afford to use just any broodstock if he is to obtain desirable products. Selection of brooders of desirable qualities is henceforth an important factor in running a successful commercial hatchery. Ripe and healthy broodstocks must be selected for spawning. Brood fish, of not less than 9 month old and not more than 3 years old, and not less than 1 kg weight, at the rate of 2 female to 1 male, is often recommended. The sexes can be separated using the following characteristics:

1. The female has a short genital papilla, while that of the male is longer and pointed
2. The belly of gravid female is rounded and extends outward, while the male fish has a slender abdomen.
3. Some eggs will ooze out when a gentle pressure is exerted on the belly of ready-to-spawn female.

Spawning techniques

In order to obtain eggs from female catfish, hypophysation techniques are employed. This method involves injection of adequate quantity of pituitary hormone to induce ovulation and subsequent release of eggs from the ovary of ripe female brooders. Nowadays, synthetic hormones are available for this purpose. The injected female is kept in a container filled with water throughout the latency period until the fish is ready for stripping. The stripped eggs must not have any contact with water until after mixing with milt (fertilization). Shortly before stripping, the male fish is sacrificed and the testes removed. The testes are lacerated and the milt squeezed into a bowl containing stripped eggs. The mixture is stirred gently for few minutes before clean water is added. The fertilized eggs are spread on egg mat (made of mosquito net) submerged inside water.

Larval rearing

Catfish eggs hatch around 24 hours of incubation, depending on water temperature. During hatching, yolk-sac larvae emerged and are usually aggregated at the darkened portions of the tank. Adequate water and feeding management are very essential at this stage. Fresh water is supplied into the rearing tank and may be aided by compressed air to increase its oxygen content. The larvae are fed with brine shrimp or other live food for up to four times a day. Uneaten food and fish wastes are siphoned regularly to keep the tank clean. These practices continue until after 10 days of hatching when the brine shrimps alone cannot

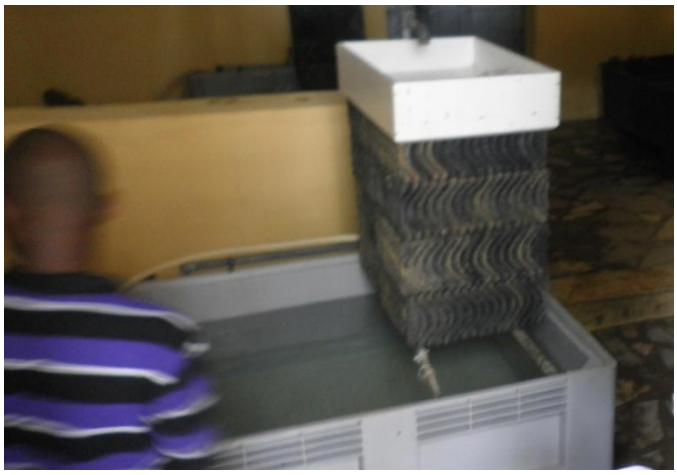
satisfy the nutrient requirements of the fish. At this time the fry is transferred into more spacious culture facilities and are fed with complete artificial diets until they reach fingerlings stage.

Water management

Most modern catfish hatcheries adopt recirculating water systems to produce fish seeds. These systems provide several advantages over the traditional static water rearing techniques. One of the benefits is that it allows greater control of the rearing environment, especially temperature, than is possible in other conventional methods. Recirculating systems also minimize water use and concentrate waste for discharge, thus reducing the volume of waste water to be treated. A major disadvantage of this system is that it must be powered by electricity, which makes it unsuitable for rural setting. In a typical recirculating systems, the major component include (but not limited to) the following;

1. Rearing units
2. Sedimentation units to reduce particulate solids
3. Biological filters to abate dissolved wastes
4. Oxygenation units to increase dissolved oxygen concentration above atmospheric saturation level
5. Advanced oxidation unit (ultraviolet UV filter) to disinfect the culture water
6. Heater/chiller to bring the water temperature to the desired level

Nowadays, there are several modifications of recirculating systems. The type that is commonly adopted for fingerlings production is as shown below.



Recirculating water system for catfish fingerling production.

This is a compacted system where sedimentation, bio-filtration and oxygenation occur concurrently. This system may be used for all stages of fish growth from eggs to fingerlings. Most farmers prefer to transfer the young fish (fry) from the recirculating system into larger rearing units and use the system to propagate another batch

Pond Farming Husbandry and Management

Earthen pond is the traditional system for fish cultivation. Majority of catfish farmed in the country are grown in ponds. Ponds can be found in different shapes and sizes, but the most common is contour pond. It has a four raised dikes, is usually rectangular, has a gently sloping bottom and a depth of 1.2 – 1.5 m, and a standard size of 20 m by 25 m. This type of pond may be built adjacent to one another, as shown below.

Contour ponds adjacent to each others.

For pond farming to be profitable, suitable resources must be available. Fish culture in pond is water intensive and requires large volume of good and quality water. The water must be free from contaminants, and the source may be well or surface water. Pond farming also requires a large areas of land with correct topography and soil type fro economical construction and operation of the ponds. Even where good water and suitable land are available, production will not be profitable without the proper infrastructure in place.

Pond preparation

Pond must be prepared before stocking with fish to ensure successful operation. New pond must be allowed to settle before they are

impounded with water for fish culture. Old pond is prepared by draining water after which excessive mud (if any) is removed and the leaks repaired. The pond is limed using quick lime, hydrated lime or agricultural lime. Lime may also be needed to increase the buffering capacity and/or enhancing organic decompositions in the pond, and in this case, agricultural lime may be preferable. The pond is then filled with water, fertilized with chicken manure or other organic manure or inorganic fertilizers, and left to stand for few days before stocking. The water in pond ready for fish stocking should have a bright greenish color, as shown below.

Pond prepared ready for stocking.

Stocking

Fingerlings or juvenile catfish are stocked in ponds and fed until they are big enough for harvest. Although ponds may be stocked as high as 10 – 30 fish/m^2, there is no “correct” density. Farmer must therefore use his discretion to choose his stocking density based on his experience, level of operation, carrying capacity, water quality and exchange rate. When determining stocking density, farmers usually calculate the likely or expected final biomass the pond can support. In this way, the fish are stocked into more space initially and are allowed to grow into it during their 4 – 6 months culture period.

Feeding

Adequate quantity of feeds must be offered daily to the fish to achieve the desired growth at the scheduled time. Feed should be fresh and palatable with a high nutritive value. Spoiled and mouldy food should be discarded to prevent disease. The fish should be provided with an amount of feed required every day, as uneven feeding causes poor

digestion, poor absorption, and slow growth. Feeding should be done at least twice a day, say 10:00 am and 4:00 pm. Feed should be given at the same place at each feeding.

Adult catfish during feeding.

Health management

The best approach to avoid high losses due to disease in pond farming is early recognition and treatment during infections. Those carrying out feeding are best able to notice slight deviations in feed intake that may indicate onset of disease or environmental changes that can induce stress on the cultured fish. The onset of disease may also be indicated by increasing number of individual fish hanging near the water surface. It is advisable to sample about 20 fish from each pond monthly and examine parasites/disease in them. Losses to diseases may not be high if fish are reared properly in terms of stocking, feeding and water exchange.

Harvesting and marketing

The best time to harvest fish from ponds is the cool periods of the day. Fish that are to be harvested should not be fed for at least 24 hours prior to harvesting. Holding tanks may be required if the fish are not sold immediately after harvesting. The fish should be weighed and counted to determine the final outputs in each pond. Marketing should be carefully planned before fish are harvested from ponds.

CHAPTER IV: THE PROCESSING UNIT OF ABUAD FARM

THE PROCESSING UNIT OF ABUAD FARM

ABUAD farm processing unit is unique because of its diverse value addition processes which make all the agricultural products well accepted in locally and internationally. The processing unit is situated right on the farm premises and this gives room for an easy vertical integration of farm produce into the processing unit. The processing unit of the farm is well equipped with modern technology which makes the products highly demanded for and competitive with other products from other countries. This unit was established with the vision to reduce waste, add value and to make agricultural products available all year round. The processing plant consists of different preservation unit for different crops, mango factory (under construction), moringa factory and the feed mill. A lot of products come out of the processing unit, which are agricultural products that have gained international recognition because of the special effect and effort of the founder Aare Afe Babalola SAN, who has put the necessary machinery in place for the production of the best of each product. The processing unit is equipped with a lot of equipment which are ranging from locally made and imported ones. This unit has helped in the creation of employment opportunity over the years with the employment of over 150 qualified staff working on full time bases in different units of the processing firm. Abuad farm processing unit staffs are highly skilled and experienced in the production processes of varieties of products produced. The environment is hygienic and neat for the production of easily or directly consumed agricultural produce like the mango fruits. The product quality is highly rated by different organizations responsible for product standard. The unit is equipped with a quality control section which is involved in the satisfaction of the customers. Major feedbacks received from customers have shown that maximum utility is derived from the consumption of the products coming out of the various units.

The Vision of the ABUAD farm processing unit is to be the foremost agricultural produce processor in the Nigerian agricultural Industry and to be the market leader in the market; through exceptional quality products and services that will guarantee customer satisfaction on crops, livestock and profitable fish farming. The mission is to be highly professional and socially responsible organization with a reputation for meeting the needs of employees; complete customer satisfaction; and creating value for stakeholders with the main objective of producing high quality products in highly hygienic environment using special equipment and

machineries. The unit has being a success because of the teamwork, professionalism, Integrity, trust, quality and supervision displayed among members of staff to good management qualities upheld on the farm. Our innovative product production techniques have given us the edge and competitiveness and trust of the consumers in value addition of products and provision of solutions to challenges faced by farmers.
The processing unit is divided into 5 sections, which include the following

1. Preservation section
2. Feed milling
3. Moringa factory
4. Bottle processing section
5. Mango processing factory.

The Preservation Section

“Waste not want not”. This age old wisdom is as relevant today as it always was. And certainly in the context of the growing world-wide need for safe and nutritious food. Food production is under the spot light because of the explosive growth in world population, effects of climate change and rapid urbanization as environmental challenges to food security. However, increasing food production especially within the large-scale farming sector is not enough to meet the growing demand for foods by humans and fodder for animals. Food losses as a result of poor post-harvest techniques such as inadequate drying, storage, transport and preservation must be reduced. Large-scale farmers especially those working in marginal or underdeveloped areas rely heavily on the products they have stored and preserved at harvest time for their year-round food supply. The major problem facing agriculture in Nigeria is perishability and this created the drive for the need of the preservation unit on ABUAD farm to support the millennium development goals of eradication of extreme poverty and hunger, and ensuring environmental sustainability as tenets of its operation. This section is highly equipped and it serves as a place where all the farm produce of ABAUD farm is being kept in order to protect it and for longer shelf life. Preservation here in ABUAD refers to a system of production, handling, and marketing Practices that maintain the integrity and purity of agricultural commodities. The preservation is done based on crop specification and feed requirement of livestock. The preservations are done with high professionalism and in such a way to preserve the natural nutrient and quality of the produce, this has made the availability of all the produce an all year thing.

Nigerian consumers want safe, nutritious, inexpensive food throughout the entire year. Unfortunately, Nigeria's climate limits the production of food for up to six months of the year. Once food is harvested, it begins to deteriorate immediately due to the following factors:

1. micro-organisms (yeast, mould, bacteria);
2. intrinsic enzymes;
3. temperature;
4. moisture; and
5. Insects and vermin.

Because of the risk of spoilage, much of our product is processed in some way to increase its availability. A food is considered preserved once it is stabilized with respect to safety and quality. It's important to note that no type of food processing can transform poor quality raw materials into good ones. It can only increase the product's shelf life. In ensuring that our product meets high standards, the processing unit uses the highest quality raw ingredients; establish good processing techniques and follow them. Maintain an appropriate product environment after processing. During preservation water is the most important factor in controlling the rate of deterioration of a food. However, knowledge of the moisture content of an agricultural produce isn't sufficient to predict its stability. It is the availability of water for microbial, enzymatic, or chemical activity that determines the shelf life of foods. This water availability is measured as water activity (aw). Water activity is measured on a scale of 0 to 1, where 0 indicates no water and 1 indicates all water. Produce spoilage micro-organisms, in general, are inhibited in produce where the water activity is below 0.6. However, if the pH of the food is less than 4.6, micro-organisms are inhibited when the water activity is below 0.85. Due to all dehydration-or drying is done. Dehydration or drying is the nearly complete removal of water from solid agricultural produce. It is one of the oldest methods of food preservation; it was traditionally carried out by the sun.

This application is used for the same reasons that liquid foods undergo evaporation-preservation, convenience and cost savings. Dried leaves and dried fruits, are just a few examples of dehydrated produce. Instead of using the sun directly which is an old method that reduces completely or that over dries the produce, a special dryer is used for the maintenance of normal water level of our produce. These dryers are solar powered and the issue of no power is not a challenge. The level of dryness are controlled and many of our products are dried in these specially designed solar dryers without losing an inch of their quality and this makes our product retain their original taste and value. The

uniqueness of these dryers reduces the risk of product spoilage. Product dried include moringa leaves (which needs to be dried before movement to the factory, yams etc. dehydration or drying is done because of the following reasons:

1. to reduce the weight and, therefore, reduce storage and transport costs;
2. to preserve produce by decreasing the water activity and increasing the solids content; and
3. to provide consumers with convenient products.

Image of the solar dryer

After drying, the produce are stored under our specially designed vacuum storage devices which are rodent free and which regulates the temperature, humidity and precipitation according to the requirement of each produce. We have different storage systems for the preservation of different produce. Our most unique storage system is the oval shaped storage center where crops like fresh tomato, vegetables, mangoes, pepper, citrus, pawpaw and bananas are kept for a very long time and still retain their freshness. There is a storage facility where our grains are kept before movement to the market or the feed mill. Chemical addition is not allowed in our storage process and this constitute to the fact that things are done in a unique and standardized way here at ABUAD farms. Non-addition of chemicals that inhabits microbial growth in produce, which includes not only those classified as preservatives, salt, sugars, wood smoke and some spices which also inhibit the growth of micro-organisms are prohibited.

The storage room

FEED MILLING

Feed manufacturing and the associated quality control programme are keys to successful livestock and fish culture. Unless the animal biologist understands and specifies the activities of the feed mill and its laboratory, profitable livestock and fish farming will be a matter of chance. Dry feeds may be ground, sifted, screened, mixed, compressed, expanded, texturized, coloured and flavoured. By one or more of these processes, a wide variety of ingredients can be prepared into a standardized product. Since most livestock have size and texture preferences and often react to colour, odour, and flavour, processing research is an integral part of livestock production. Feed milling or manufacturing is simply a process of producing a complete feed that gives the animal the quality of nutrients necessary for growth and development. The feed mill aspect of the ABUAD farm is sophisticated and it produces the best of complete feed for farmers profit realization. The feed mill serves as a vertical integration unit of the farm in which it produces the feeds consumed by livestock on ABUAD farm and also produces complete feed for commercial purpose. A good ratio of the ingredients comes directly from the Abuad farm while those that cannot be produced in ABUAD are sourced outside.

Complete feed

A thoroughly blended mixture of different feed ingredients formulated to meet specific nutrient requirements that allows for greater efficiency in feeding and provides better control of nutrient intake. A complete feed may or may not include the roughage portion of the ration. At ABUAD's feed mill section, our complete feeds are produced based on animal specifications and requirements with the best of ingredients and well trained qualified staffs. The feed mill is equipped with more than 10 staffs working on regular shift and unit specialization. The feed mill is sophisticated in respect to the types of equipment used and machineries put in place. A good range of the products include the fish sinking pellet feed, layers mash, broiler starter and finisher, pig feed and quail feed. Our feeds are formulated by specialists who are well experienced in feed formulation.

Types of feed

Compound feed: One of the most common types of feeds used by commercial farmers is compound feed. Also known as feedstuffs, they are blends of various additives and raw materials that are formulated to specifically suit the intended animal. They are often produced as pellets or crumbles. Like modern vitamins with humans, they can be used to either satisfy the complete nutritional requirements of their target animals or as a supplement to other staples of the animals' diets. They are often complemented with extra vitamins and minerals. It is produced in astronomically large amounts, with over 600 million tons produced annually on a global scale. But at the feed mill of ABUAD farm, 5 tons of compound feed is produced per day. This caters for the feed need of the livestock and fisheries on the farm and the requirements of the customers. A bag of complete compound feed is sold at a rate that is easy and affordable by farmers. Examples of our compound feed are layer mash, broiler starter and finisher, fish pellet etc

Fodder: Another type of animal feed used primarily to feed domesticated livestock such as goats, sheep, cattle, horses and pigs. It typically composes of plant matter like hay, straw and grains. The term is used to describe these plants being given to the animals after the plants have been harvested, which contrasts with forage, as will be explained below. Meat and bone meal are occasionally mixed into fodder, which has been frequently blamed for the spread of mad cow disease and has been banned in many countries. The fodder feeds are produced mainly for the pigs and ruminants on the farm. Major example is the pig feed.

Types of feedstuffs used for the production of our livestock feeds. There are mainly 3 categories of feedstuffs:

1. Concentrates
2. Roughages
3. Feed additives

Concentrates: These are feedstuffs high in nutrient density and are easily digestible. They are also referred to as supplements because they are used to balance protein or energy deficiencies in diets. Some common examples of energy and proteinous concentrates are shown below.

Common concentrates (energy and protein) in Abuad farm feed mill.

Energy concentrates	
i. Cereal grains and their by-products	Maize, corn-gluten, corn-husk, corn-bran, millet, sorghum etc
ii. Root tubers and their by-products	Cassava chips, cassava peels, cocoyam peel, banana/plantain peels, yam peels, sweet potato and its peels
iii. Fats and oils (plant and animal origins)	Soybean oil, coconut oil, cotton seed oil, lard from pork, sunflower oil, palm kernel oil tallow from beef etc
Proteinous concentrates	
Plant protein	Sesame seed and cake, soybean seed and cake, cotton seed and cake, sunflower seed and cake, coconut cake, groundnut cake etc
Animal protein	Fish meal, meat and bone meal, blood meal, dry animal manure etc

Roughages: These are highly fibrous feed materials (plants) which are bulky and not digestible by monogastrics. But to some extent, ruminants can degrade roughages in the rumen. Some common examples of roughages used for livestock production found in Nigeria are shown below.

Examples of roughages commonly used in livestock production in ABUAD farm feed mill.

Leguminous roughages	Centro, stylosanthes, mucuna, groundnut haulm, cowpea husk, calopogonium, Bambara nut etc
Roughages from grass	Gamba grass, Guinea grass, elephant grass, signal grass, spear grass etc
Roughages from crop residues	Corn-cob, corn-straw, sorghum straw, rice straw, wheat straw, husks from cereals etc

Additives: Feed additives are a group of feed ingredients that can cause a desired animal response in a non-nutrient role such as pH shift, growth, or metabolic modifier. They are products used in animal nutrition for purposes of improving the quality of feed or to improve the animals' performance and health, e.g. providing enhanced digestibility of the feed materials. There are mainly two types:

1. Nutrient feed additives e.g. vitamins and trace minerals
2. Non-nutrient feed additives e.g. antibiotics, hormones, antioxidants

Feed additives commonly used in livestock feeds in ABUAD farm feed mill

Nutrient feed additives	
a) Vitamins	Water soluble vitamins: B-complex; thiamin, niacin, riboflavin, pantothenic acid, choline, $B_{12,}$ folic acid, vitamin C
	Fat soluble vitamins: A,D,E and K
b) Minerals	Macro minerals: Ca, P, Na, Cl, K, S
	Micro elements: Mn, Zn, Mo, Fe, Co, I, Cu
Non-nutrient feed additives	
a) Antibiotics	Teramycine
b) Hormones	Growth hormones
c) Medicants	Antioxidants, ethoxyquine

Factors governing the types of feedstuff used to compound animal feed in ABUAD farm feed mill include.

Cost: The lower the cost of feedstuffs, the lower the cost of feed production and the better the profit. Cost of purchasing feedstuffs influences the selling price of feed. However, costly feedstuffs do not necessarily produce the best feed.

Availability: Feed formulation and production should be guided by the availability of feedstuffs in a location at a particular season. Inaccessibility feedstuffs can be tackled by recommending feedstuffs that can be interchangeably used e.g. DOC can be used when there is no PKC.

Type of animal on the farm: When dealing with ruminants, fibrous feedstuffs are inevitable for optimum performance of your herd. However, highly fibrous feedstuffs are prohibited in monogastrics especially poultry. Hence, the type of animals raised by a farmer

determines the kind of feedstuffs to be used to compound feeds for his animals.

Physiological state/stage of the animal: This refers to the productive stage of an animal. The animal can be dry, gravid or lactating (ruminants). The physiological state dictates the feedstuffs mixed together to make the feed.

Nutrient composition of the feedstuff: Highly fibrous untreated feedstuffs are not good for raising monogastrics. However, ruminants do subsist on fibrous feed materials.

Chemical Analysis of Feeds/Feedstuffs

Chemical analysis is carried out in the laboratory through the use of chemicals to determine the nutrient composition of feeds/feedstuffs. We carry out chemical analyses of feeds/feedstuffs for the following reasons:

1. Economic comparison
2. Digestibility
3. Productive/nutrient value and composition
4. Possible toxicity

To check the adequacy or otherwise of feed for its fitness to meet the requirement of the animal to be fed. The chemical analysis is carried out by analyzing for proximate composition (crude protein, crude fibre, ether extract, ash and nitrogen free extract) as well as the fibre fractions, anti-nutritional factors, minerals and/or vitamins. This is done by our quality control unit of the feed mill section.

Proximate Composition

Ash: This is the remains/residue of weighed sample burned in a muffle furnace at 500-600 °C for 2 hrs. The organic portion has escaped and inorganic or mineral portion is left. Most times, it is less than 10%.

Crude protein: Also known as Kjeldahl procedure is used to determine the protein portion of a feed/feedstuff. It determines the nitrogen part of feed and the nitrogen portion is multiplied by 6.25 with the assumption that protein contains an average of 16 % nitrogen.

Crude fibre: This is fibre portion of feed material. It comprises of hemicellulose, pectin, cellulose and lignin.

Ether extract: This is also known as crude fat because petroleum ether used for fat extraction also extracts all ether extractible substances

which are not fat. Examples are: steroids, fat soluble vitamins, resins, chlorophyll etc.

Nitrogen free extract (NFE): It is the soluble carbohydrate portion of the feed. It can be obtained by subtracting the addition of crude protein, crude fibre, ether extract and ash from 100 %.

Feed Milling Processes

The feed milling operation is carried out in two sections which results in the production of the livestock feeds and fish pellets from each section. The processing involves different machines which produces specific type of feeds for different animals. The fish pellet is produced using the vertical mixer while the livestock feed is produced using the horizontal mixer. The process involved in our feed production goes through a chain of activities which include:

1. Collection of materials or ingredients from the store
2. Knowing the quality of the material
3. Weighing of materials required for production
4. Grinding
5. Mixing
6. Pelleting (fish feed)
7. Weighing and Bagging

Collection of Materials of Ingredients from the Store

The ingredients used for our feed production are sourced from ABUAD farm in large quantities and the ingredients not produced are sourced from the outside market. Materials like maize, groundnut cake (GNC), Maize, corn-gluten, corn-husk, corn-bran, millet, sorghum, Cassava chips, cassava peels, cocoyam peel, banana/plantain peels, yam peels, sweet potato peels, Soybean oil, coconut oil, cotton seed oil, lard from pork, sunflower oil, palm kernel oil tallow from beef etc are received from the farm while the other materials like lysine, methionine, salt, bone meal, vitamins and minerals are supplied through our supply chain. The materials are stored in our storage room until they are used. This does not affect the quality of the material because of the kind of storage system put in place. Most of the ingredient does not use more than one week in the store before they are used. When production is about to take place the materials are collected from the store.

Knowing the Quality of the Material

After collection of the materials, the chemical composition of each material is examined before they are used. The chemical analysis is carried out by analyzing for proximate composition (crude protein, crude

fibre, ether extract, ash and nitrogen free extract) as well as the fibre fractions, anti-nutritional factors, minerals and/or vitamins. Certain quantity of the various materials are collected as sample and taken for the test and analysis in the laboratory.

Weighing of Materials Required for Production

The materials are weighed according to the requirement of the type of feed that is about to be produced. This is done in line with the feed formulae.

Grinding

Grinding or particle-size reduction is a major function of feed manufacturing. At ABUAD farm feed mill, we pass all incoming ingredients through a grinder for several reasons:

1. to reduce the size of clumps and large fragments
2. some moisture is removed due to aeration, and
3. additives such as antioxidants may be blended.

All of these improve the ease of handling ingredients and their storability. There are other reasons for grinding and the associated sieving of ingredients in formula feeds before further processing. Livestock, small fish and fry require plankton-size feeds available in dry form as a meal or granule. Extremes in particle sizes are wasteful and often dangerous. Fry gets killed because of its small digestive system, holding inability for connective tissue and bone present in dry animal byproducts, or hull fragments found in cotton seed meal and rice bran to pass through. On the other hand, dust or "fines" may become colloidal suspensions in water, so dilute that several mouthfuls carry little nutritive value. The grinding of ingredients generally improves feed digestibility, acceptability, mixing properties, pelletability, and increases the bulk density of some ingredients. It is accomplished by many types of manual and mechanical operations involving impact, attrition, and cutting.

Hammer mills

Hammer mills are mostly impact grinders with swinging or stationary steel bars forcing ingredients against a circular screen or solid serrated section designated as a striking plate. Material is held in the grinding chamber until it is reduced to the size of the openings in the screen. The number of hammers on a rotating shaft, their size, arrangement, sharpness, the speed of rotation, wear patterns, and clearance at the tip relative to the screen or striking plate are important variables in grinding capacity and the appearance of the product. Heat imparted to the material, due to the work of grinding, is related to the time it is held within

the chamber and the air flow characteristics. Impact grinding is most efficient with dry, low-fat ingredients, although many other materials may be reduced in size by proper screen selection and regulated intake. Most hammer mills have a horizontal drive shaft which suspends vertical hammers but for some ingredients, such as dried animal byproducts, a "vertical" hammer mill is more efficient. In this mill, the drive shaft is positioned vertically and screens and hammers are positioned horizontally. Materials successfully reduced in size to the diameter of screen holes or smaller, are carried by gravity outside the mill and thence by air or conveyor to storage in "make-up" bins. Over-size particles, not easily broken, drop through the mill and may be re-cycled or discarded. Thus foreign materials, such as metal and stones, are discharged before they are forced through the screen causing damage.

Attrition Mills

Attrition mills use the hammer mill principle to a certain extent; i.e., shattering by/impact. However, they also impart shearing and cutting action. Grinding is done between two discs equipped with replaceable wearing surfaces. One or both of these discs is rotated; if both, they rotate in opposite directions. When one disc is rotated, and the other stationary, the assembly is used for shredding and deferring. Often materials which have been coarsely ground by other mills, are passed through an attrition mill for blending or smoothing out an ingredient or mixture containing liquids which may have clumps. The discs of an attrition mill are generally in a vertical position so that materials not capable of reduction can pass by gravity out of the grinding area.

Roller Mills

A combination of cutting, attrition, and crushing occurs in roller mills. These are smooth or corrugated rolls rotating at the same speed set at a pre-determined distance apart with material passing between the two. A tearing action may be added by operating the rolls at different speeds and by corrugations which are different for each roll; i.e., the top roll may have off-radial spiral corrugations and the bottom roll lateral corrugations. This last type, called a "Le Page cut" is used in making granules from hard pellets, as it provides a breaking surface without much impact to cause dust. Roll grinding is economical but limited to materials which are fairly dry and low in fat.

Cutters

Rotary cutters are a type of grinder which reduces dry particle solids mainly by shearing with knife edges against a striking plate. The mill also includes the processes of attrition and impact, although these actions

are limited if the material is easily reduced by cutting and the screen limiting discharge has large perforations. The mill consists of a rotating shaft with four attached parallel knives and a screen occupying one fourth of the 360 degree rotation. The mill is best used to crack whole grains with a minimum of "fines". It is not used as a final process for reducing the size of ingredients used in fish feeds.

Screening

Associated with grinding feeds for fish fry, a sieving system is required which classifies materials to any desired particle size. The "overs" in this system may be re-ground or rejected. The "throughs" may be selected to comply with fish preferences for size and mixed according to formula specifications. Feeds sifted through a 177-micron opening (a U.S. No. 100 sieve) have been successfully used for increasing survival and growth of minnows and catfish fry. Hammer mill or impact grinding of dry feeds, especially cereal grains, creates particles within the range called "dust", and a dust-collecting system may be necessary to remove this. An excess of dust in the feed may lead to gill disease, a situation where organic matter adhering to gills becomes a nutrient for bacteria or parasites. The problem of excess dust formed by grinding feeds may be partly alleviated by adding a spray of oil or a semi-moist ingredient, such as condensed fish solubles or fermentation solubles, on feeds entering the grinder. Dehydrated alfalfa is prepared as a dust-free meal, similar in texture to a sifted crumblized pellet, by spraying mineral oil into a hammer mill chamber during grinding.

Mixing

The objective of feed mixing is to start with a certain assortment of ingredients called a "formula", totaling some definite weight. This is processed so that each small unit of the whole, either a mouthful or a day's feeding, is the same proportion as the original formula. Mixing is recognized as an empirical unit operation, which means that it is more of an art than a science and must be learned by experience. Feed mixing may include all possible combinations of solids and liquids. Within each ingredient are differences in physical properties. For solids there are differences in particle size, shape, density, electostatic charge, coefficient of friction as represented by the angle of repose, elasticity or resilience and, of course, color, odor, and taste. For liquids there are differences in viscosity and density. The term "mixed" can mean either blended, implying uniformity, or made up of dissimilar parts, implying scattering. As applied to formula feeds, the objective of mixing combines each of these definitions; i.e., the scattering of dissimilar parts into a blend. However, it is improbable that uniformity is attained with particles

within a, sample arranged in some order of position or concentration. That is only a quality control; goal. It has been suggested that a proper title for a discussion of mixing should be "mixing and unmixing", for during the operation there is a constant tendency of particles which have been mixed to become separated. Three mechanisms are involved in the mixing process:

1. The transfer of groups of adjacent particles from one location in the mass to another,
2. Diffusion distribution of particles over a freshly developed surface,
3. Shear slipping of particles between others in the mass.

In theory, the position of particles within a container is determined by chance, and the effects of chance accumulate until they outweigh the direct effects of mixing action. In the mixing of liquids, chance movement of components creates order or uniformity. With dry solids, chance distribution creates disorder. When disorder is at a more or less stable maximum, it may be called "random". Many factors in dry solids cause particles to avoid a chance or random arrangement. In fact, the result of mixing feed ingredients may be a definite pattern of particle segregation or non-random arrangement. Particle segregation is due to differences in the physical properties of ingredients and the shape and surface characteristics of the mixer. Particle size may be the most important factor in causing segregation. An improvement in mixing which approaches random distribution of solids by decreasing particle size can be measured quantitatively by statistical methods. In general, the smaller and the more uniformally sized the ingredients are prepared, the more nearly they will approach random distribution during mixing.

In many formulae, a decrease in particle size is necessary to attain a sufficient number of particles of an essential additive (vitamin, mineral, medication) for dispersion in each daily feed unit. This may require the particle size to be the diameter of dust, 10 to 50 microns. Certain ingredients are unstable in finely divided form and likely to acquire an electrostatic charge. Concentration of particles on a charged surface, roughness of the mixed and stickiness of oily and wet ingredients are factors in causing segregation when very small particles are mixed and when these are much smaller than the bulk of other ingredients. Mixing may be either a batch or a continuous process. Batch mixing is done on an open flat surface with shovels or in containers shaped as cylinders, half-cylinders, cones or twin-cones with fixed baffles or moving augers, spirals, or paddles. Continuous mixing proportions by weight or volume, is a technique best suited for formula feeds with few ingredients and minimal changes.

Horizontal Mixers: Continuous ribbon mixers

The continuous or "twin-spiral" mixer consists of a horizontal, stationary, half-cylinder with revolving helical ribbons placed on a central shaft so as to move materials from one end to the other as the shaft and ribbon rotate inside. Capacity can be from a few liters to several cubic meters. The speed of shaft rotation will vary inversely as the circumference of the outer ribbon; usually optimum between 75-100 meters per minute. Since material travel is from one end to the other, either end may be used for discharge. These mixers may be inverted for cleaning.

Horizontal Mixers: Non-continuous ribbon mixers

Non-continuous or interrupted ribbons are similar to the continuous ribbon mixers except that short sections called "paddles" or "ploughs" are spaced in a spiral round the mixer shaft. Action is different from that of continuous ribbon mixers, and may be more satisfactory for mixing liquids with dry solids. These mixers are made in a wide variety of sizes with travel of the outer diameter of paddles from 100 to 120 meters per minute.

A horizontal mixer

Vertical Mixers

Vertical mixers may consist of a cylinder, cone, or hopper-shaped container, with a single or double screw (auger) located vertically through the centre. The screw operates at speeds of 100 to 200 rpm and vertically conveys incoming materials from the bottom (generally the

intake) end, like a screw conveyor, to the top where they are scattered and fall by gravity. This sequence is repeated several times until a blend is attained (usually from 10 to 12 minutes). These mixers may also be loaded from the top. Results show that vertical mixers are not efficient for uniform mixing of solids and liquids or for materials of quite different particle size or density. This unit is difficult to clean and there may be inter-batch contamination.

Other Types of Mixers Used on ABUAD farm feed mill include; Horizontal revolving drum which can be a straight-sided cylinder or a cylinder tapered at each end. The sides are smooth or fixed with baffles or shelves to pick up and drop ingredients. Smooth, dry materials of uniform physical properties are blended best in this type of mixer.

Liquid Mixers

Oils and water-miscible oil preparations are often added to dry ingredients as a source of energy or as a specific nutrient. Although the oil-soluble vitamins. A, D, E, and K, are available in dry carrier concentrates; they may be obtained in pure form and premixed by the feed manufacturer. Liquids containing nutrients can be mixed faster and with more uniformity than the same nutrient in dry concentrate condition. Therefore, a liquid blender may be needed in the feed plant. Liquid blenders usually consist of a horizontal tub or cylinder with a number of wires or paddles equally spaced around a shaft which revolves inside. Sometimes the shaft is hollow and liquids are forced through holes in the paddles in a spray effect. Some models have a shaft speed of 400 to 600 rpm while others rotate at 1200 rpm. Ingredients such as condensed fish or fermentation solubles, molasses, or fish oils are often premixed in a bowl type variable speed mixer, blending the liquid with dry ingredients.

Mixing Operation and Evaluation

Accurate mixing requires the addition of ingredients in a tested sequence from batch to batch. The usual practice is to add large-volume ingredients first, then those of smaller amount. Unless already premixed, liquids should be added after all dry ingredients have been mixed. Total mixing time is critical and is influenced by the composition of the formula. All mixers should be calibrated by laboratory recovery of known additives (physically or chemically) so that under and over mixing does not occur. Uniformly sized salt, graphite, or iron particles coated with water soluble dyes are often used as "tracers". Each mixer should be calibrated for its mixing time and capacity by volume for best results.

Pelleting

In the case of fish feed it has to be pelletized before it can be called a fish feed and this is done by transforming soft, often dusty feed into a hard pellet and is accomplished by compression, extrusion, and adhesion. The general process involves passing the feed mixture through the conditioning chamber where 4 to 6 percent water (usually as steam) is added in other types of fish feed the dusty feed is heated to an unknown degree and other local substances like the popular cassava flour meal (garri) is added to make it hard in its pellet form but with the help of our sophisticated pellet mill which are coupled directly with the vertical mixer the pellets are easily produced without stress and the resultant pellet produced is harder and stays longer hard even in water than any other type of pellet feed. Moisture provides lubrication for compression and extrusion and in the presence of heat causes some gelatinization of raw starch present on the surface of vegetative ingredients, resulting in adhesion. Within 20 seconds of entering the pellet mill, feed goes from an air-dry (about 10-12 percent moisture) condition at ambient temperature, to 15-16 percent moisture at 80-90°C. During subsequent compression and extrusion through holes in a ring' die, friction further increases feed temperature to nearly 92°C. Pellets discharged onto a screen belt of a horizontal tunnel drier or into a vertical screened hopper are air-cooled within 10 minutes to slightly above ambient temperatures and dried to below 13 percent moisture. Abuad fish pellet feed is a finished pellets that contain practically all the nutrients found in feedstuffs and additives as compounded.

Application

Mechanically, our process of pelleting involves forcing soft feed through holes in a metal ring-type die. These holes are round or square, tapered or non-tapered . Single or double rolls mounted inside the die ring on a cam or eccentric, turn on a rotating shaft as friction develops (due to the presence of feed between roll and die). The feed is forced through the die holes in increments so that dissection of a finished pellet shows tight layers of feed mixture. The die is driven by a motor and the rolls turn only as feed between rolls and die develops friction.

Overall, the texture of the soft feed mixture is changed from a meal-like material with bulk density approximately 0.4 g/cc, to a pellet with bulk density of 0.5 - 0.6 g/cc. Within the ring die, pressures of 75-600 kg/cm^2 are attained. Pellet quality may be defined as a certain hardness or water stability which assures efficient use without loss in handling on land or in water. Feed formulation and operation of the pellet mill is balanced to supply fish with a feed that is acceptable, available, and

easily digested. Pelleting process in ABUAD farm feed mill is more of an art than a science.

Hard pellets

A combined pellet milling machine (hammer mills and vertical mixer)

The compressor unit of the pelletizing machine

Cooling and Drying

The temperature imparted to pellets in the process of their manufacture assists the removal of moisture by the air-drying process. Generally, within ten minutes after extrusion, hard pellets are cooled to ambient temperature and brought to moisture content slightly above that of the entering soft feed. This is done by done by passing the hot pellets through a vertical or a horizontal chamber designed to bring air at ambient temperature into intimate contact with the outer surface of the pellets.

Weighing and Bagging

After the feeds are well processed the next thing is branding and this is done with the consideration of the farmers who cannot afford to purchase large quantities of feed at a time for their livestock so we weigh in different kilogram sizes ranging from 25 kg to 50 kg. This is done in order to make the feed affordable and bagging is done in a well improved water resistant bag than can stand the test of any weather and it makes our product well accepted and preferred above other feed products in the market.

Well bagged finished fish feed.

Well packaged layer mash

MORINGA FACTORY

The *Moringa oleifera* tree is known worldwide for its nutritional and medicinal benefits and industrial uses. Almost every part of the moringa plant has nutritional value. They can be consumed fresh, cooked or dried. Since dried Moringa leaves retain their nutrient content, it is possible to convert them into leaf powder. Since there is an abundance

of leaves, this leaf powder is made and stored easily. Moringa Leaf Powder is an excellent nutritional supplement and can be added to any dish. The root can be used as substitute for horseradish. Foliage is eaten as greens, boiled, fried, in soups or for seasoning. Dried leaf powder can be added to any kind of meal as a nutritional supplement. The seed can be roasted and eaten. Since the moringa plant is a fast-growing tree grown throughout the tropics and sub-tropics and because of its fast growing demand, the founder of Abuad Aare Afe Babalola has contributed immensely into the green revolution by adopting different ways of utilizing the blessed plant and ways of preserving it for export and the dream is to make Nigeria a leading supplier of this plant. The establishment of the moringa factory has brought about the production of different products using the moringa plant has the key ingredient and the moringa production unit of Abuad has become a reputable organization in the realm of manufacturing moringa health products. The following are the things that have been produced using moringa plant:

1. Abuad moringa leaf powder
2. Abuad moringa seed
3. Abuad moringa capsule
4. Abaud moringa hair cream
5. Abuad moringa oil
6. Abaud moringa body cream
7. Abuad moringa tea
8. Abuad moringa soap

In the processing of moringa plant into this various products a lot of activities have taken place and the use of modern technology has made the production and packaging unique. The processing factory is equipped with over 35 staffs that are well experienced and well trained and all persons involved in the production and packaging of our moringa products also ensure that, while on duty, personal cleanliness and hygiene are maintained. Personal protective equipment (PPE) such as head caps, nose masks, disposable gloves, etc. is used at all times. The hygiene of the processing factory is of paramount importance to the production.

ABUAD Moringa Leaf Powder

Processing starts immediately after harvesting and transportation of the leaves to the processing point. The processing goes through the following procedures:

Stripping the leaflets: Strip all the leaflets from the leaf petiole. This is done directly from the branches if the leaves have not been stripped off the main branch before transportation. During this procedure any

damaged or discolored leaves is set aside for animal feed or compost. [Stems and branches are also used as animal feed or in compost.] Leaves are then rinsed in clean water or a very weak bleach solution (1:100) to remove dirt and germs.

Washing: The leaflet is washed in troughs designed especially for washing using clean potable water to remove dirt. Then the leaves are washed again in 1% saline solution for 3-5 minutes to remove microbes. It is then finally washed again in clean water. Leaves are now ready for drying. Note: the trough is drained after each wash and fresh leaves must always be washed with fresh water.

Draining: Water is strained from the leaves in buckets that have been perforated, leaflets is spread on trays made with food-grade mesh and left to drain for 15 minutes before taking them to the dryer.

Drying: Drying of the leaves is done in three different ways at the Abuad moringa processing plant. And they are:

Room drying: The leaves are spread thinly on mesh tied on racks in a well-ventilated room. This room is insect, rodent and dust proof. Air

circulation improved by using ceiling vents protected with a clean filter to keep the sun and dust out. The leaves are turned over once in a day with gloves, to improve uniform drying. With this method the leaves will be completely dry within a maximum of 4 days. However, this is the first method been used in drying our moringa leaves but because room-dried leaves cannot be guaranteed mould-free with the maximum recommended moisture content of 10%. Therefore, we introduced the solar drying method.

Drying Room

Solar drying: The solar dryer presented in the pictures is presently been used and the metal plate is been used instead of UV treated or opaque. The air intake is filtered to keep out dust. Leaves are then spread thinly on mesh and dry in the dryer for about 4 hours. The final product is always very brittle. The solar dryer has improved our efficiency and increased our production rate and this has also reduced the mitigating factor poor electricity supply in Nigeria and it also lowers our cost of production because the huge amount that is supposed to be used in powering the generating set is been spent on production efficiency.

Solar Dryer

Mechanical drying: Both electric and gas hot-air dryers are used. Drying temperatures should range between 50 °C and 55 °C. If temperature exceeds 55 °C, leaves will "burn" and turn brown. Leaves are dried until their moisture content is below 10 %. This method is the best because it guarantees us an all year round production.

Mechanical dryer

Milling: The dry leaves are milled using a stainless steel hammer mill for routine milling of our products.

Moringa milling machine

Sieving: Sieving is done after milling the leaf powder if need be because when the hammer mill is used, the fineness of the product depend on the size of the screen used in milling.

Drying the leaf powder: Moringa leaf powder strongly attracts moisture and the product can reabsorb humidity during or after milling. For this reason, the moringa leaf powder is left to dry at 50 ºC for about 30 minutes to reduce moisture content considerably below 7.5 %.

Packaging in bulk: During packaging the temperature and humidity must be controlled in the packaging room, to avoid re-humidification of the product. After drying, the powder is left to cool and packed into clean, single-use polythene bags and sealed. This is enclosed in a second polythene bag and heat-sealed. This is to maintain freshness and dryness prior to further use. The bags should be stored in a cool, dry place.

Final packaging: Abuad Moringa leaf products are packaged in two different ways. In clean, dry and opaque containers made of materials that do not affect the quality of the product. Each package is properly sealed to prevent content leakage as well as moisture absorption.

In tea bags that is properly sealed and hygienically handled. And this forms the “ABUAD MORINGA TEA”

Cross section of abuad moringa tea bags

In capsules, the moringa leaf product is packaged in such a way has to make it acceptable globally and also in a way to make it look modern. The moringa leaf product is packaged in aqueous solutions of gelling agents known as gelatin which are in hard-shelled forms and generally referred to as capsule

Labeling: Each package of Abuad moringa leaf product is legibly marked with the following information:

1. Name of product
2. Net content
3. Name and address of Abuad
4. Country of origin
5. Lot / batch identification number or code
6. Instructions for use
7. Production date
8. Nutritional information.

ABUAD Moringa Seed

The moringa seeds are harvested when they are dry and transported to the processing factory where they are subjected to a lot of treatments which kills the germs present and in most cases the seeds are dried either directly by using the solar dryer or the mechanical dryer because the moisture content as well has to be at the lowest minimal level thereby still leaving the natural quality of the product intact. A good handling procedure is also done here by our able and qualified workers. The cleaned seed are then packaged in clean, dry and opaque containers made of materials that do not affect the quality of the product. Each package is properly sealed to prevent content leakage as well as moisture absorption.

ABUAD Moringa Seed Oil

Moringa seed crusher used for the extraction of moringa oil.

Cross section of Abuad moringa seed oil.

The moringa oil is obtained by pressing the seeds of the moringa oilefera tree with our old extractor machine. The moringa seeds yield about 38-40 % edible oil which can be used in cooking, cosmetics and

lubrication. The abuad moringa oil is good for cooking and it also has a tremendous cosmetic value and it is also used in making abuad moringa body and hair care as a moisturizer for skin condition. It is also a major ingredient in abuad moringa soap production. After extraction the oil is packaged in a clean, dry and transparent bottle made of materials that do not affect the quality of the product.

ABAUD Moringa Body Cream and Hair Care

The ABUAD moringa body cream and hair care are two different all natural products that are highly formulated to protect human skin and highly formulated with natural ingredient with moringa having the highest proportion. Our moringa body cream making factory is equipped with sophisticated machines and a host of experienced staffs that contribute immensely to the production of the all natural soap. The moringa seed oil and leave products is an essential ingredient used in the manufacturing of the moringa body cream and hair care.

ABUAD Moringa Soap

Soap is the product of a chemical reaction known as saponification. In order for saponification to occur, the moringa oil extract is mixed with a strong alkali. After making the soap with the meat and pour method. The soap product is then o as to preserved in a closed container so as to preserve the scent of the soap as long as possible after they have cured. In general paper bags and cardboard boxes do a better job at preserving scents than plastic. That is why we prefer the paper and cardboard boxes for packaging.

Cross section of finished ABUAD moringa soap

BOTTLE PROCESSING SECTION

Plastic Bottles nowadays is something that is in high demand, mainly because of its durability. Majority of people around the world use it on a daily basis. Containing innumerous uses, plastic bottles or plastic to be specific is one of the greatest discoveries in the recent centuries. PET Bottles as they are called are used for packing of Edible oils, jams and sauces, Butter, syrups, drinking water etc having various capacity. PET resin are extruded and converted to pre-forms and later molding is done to make the PET Bottles by using the pre-forms. Most of the moringa products are well packaged in PET bottles of different sizes and shapes. This gives our products the best of packaging against all kinds of depreciating additions that adds to such products. To reduce cost and create better efficiency in our production a PET blowing factory was consolidated to produce the best type of bottles needed for effective packaging of the products. Production of PET Preforms and PET Bottles involves the conversion of PET Granules to Preforms and later converting to PET Bottles through moulding process.

PET Blowing Machine

MANGO PROCESSING FACTORY

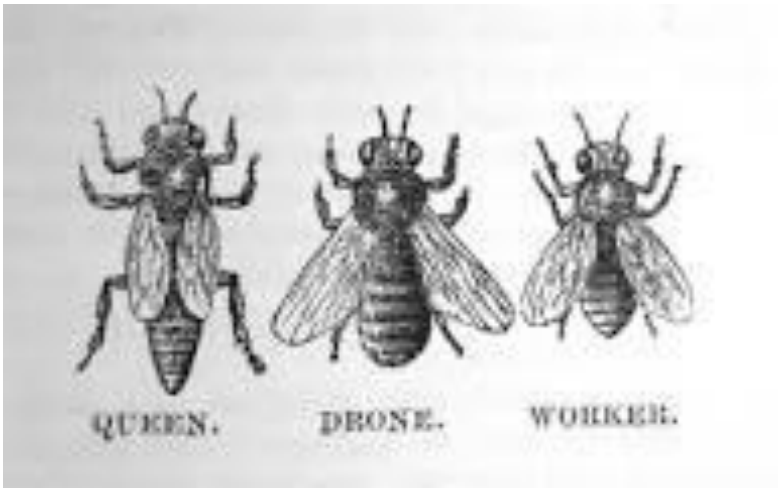
Mangoes are important part for adequate diets in certain parts of the world. The edible portion of the fruit varies from 55 to 75 percent depending upon the variety. The vision of the Abuad mango farm is to produce mangoes of best quality and creating a platform for the marketing of mangoes. To produce dried mango as snack food seems which is an unexploited possibility To create an awareness for the benefit and utilization of the factor endowed produced mangoes in Nigeria and to reduce waste of mangoes the ABUAD farm decides to produce mangoes in different forms aside from the table mangoes that can be consumed raw. The quest for the transformation of mango has led us to the production of a variety of products with the use of standard modern technology and a host of skilled workforce. Among the products produced are mango juice, mango chips etc. though the activity of producing this mango product is still limited because the mango production factory is still under construction as at the time of filing this; The technology required for the canning unit are washer, fruit crusher, pulper, pasteurizer, packing machine, cap sealing machine, boiler, laboratory equipment and other accessories etc, which are already on ground. The fresh mangoes are well packaged for export.

Processed ABUAD Mango Products

CHAPTER V: BEE KEEPING

BEE KEEPING

Beekeeping can be a fascinating business or a profitable occupation. You may want to keep bees for the delicious fresh honey they produce, for the benefits of their valuable services as pollinators, or perhaps simply for the enjoyment of learning more about one of nature's most interesting insects. Honey bees normally stings alone to defend themselves or their colony, when colonies are handled properly and precautions are taken, stinging is not a major problem. Most beekeepers develop a tolerance for bee venom over time and have reduced sensitivity to pain and swelling. However, the few people who react strongly to bee stings and pollen or who are unable to get over fears of stings should avoid contact with bees. Beekeeping is generally considered a minor industry. However, because of its interrelationship with agriculture and dependency of growers of several commodities on honey bee pollination, beekeeping is much more important than merely the value of the beeswax and honey produced annually.



Types of Bees

Organization of Colony

Honey bees are a social insect, which means that they live together in large, well-organized family groups. Social insects are highly evolved insects that engage in a variety of complex tasks not practiced by the multitude of solitary insects. Communication, complex nest construction, environmental control, defense, and division of the labor are just some of the behaviors that honey bees have developed to exist successfully in social colonies. These fascinating behaviors make social insects of them

in general. A honey bee colony typically consists of three kinds of adult bees: workers, drones, and a queen. Several thousand worker bees cooperate in nest building, food collection, and brood rearing. Each worker has a definite task to perform, related to its adult age. But surviving and reproducing take the combined efforts of the entire colony. Individual bees (workers, drones, and queens) cannot survive without the support of the colony. In addition to thousands of adult workers, a colony normally has a single queen and several hundred drones during late spring and summer. The social structure of the colony is maintained by the presence of the queen and workers and depends on an effective system of communication. The distribution of chemical pheromones among members and communicative “dances” are responsible for controlling the activities necessary for colony survival. Labor activities among worker bees depend primarily on the age of the bee but vary with the needs of the colony. Reproduction and colony strength depend on the queen, the quantity of food stored, and the size of the worker force. As the size of the colony increases up to a maximum of about 60,000 workers, the efficiency of the colony also increases.

Bee Development

All the three types of adult honey bees pass through three developmental stages before emerging as adults: egg, larva, and pupa. The three stages are collectively labeled brood. While the developmental stages are similar, they do differ in duration. Unfertilized eggs become drones, while fertilized eggs become either workers or queens. Nutrition plays an important part in caste development of female bees; larvae destined to become workers receive less royal jelly and more a mixture of honey and pollen compared to the copious amounts of royal jelly that a queen larva receives.

Developmental stages of the three castes of bees.

Developmental Stage Days	Duration of Stages Queen	Worker	Drone
Egg	3	3	3
Larval stage	5 1⁄2	6	6 1⁄2
Pupal stage	7 1⁄2	12	14 1⁄2
Total Developmental time	16	21	24

Brood

Eggs. Honey bee eggs are normally laid one per cell by the queen. Each egg is attached to the cell bottom and looks like a tiny grain of rice. When first laid, the egg stands straight up on end. However, during the 3-day development period the egg begins to bend over. On the third day, the egg develops into a tiny grub and the larval stage begins.

***Larvae*.** Healthy larvae are pearly white in color with a glistening appearance. They are curled in a "C" shape on the bottom of the cell. Worker, queen, and drone cells are capped after larvae are approximately 6, 5½, and 6½ days old, respectively. During the larval stage, they are fed by adult worker (nurse) bees while still inside their beeswax cells. The period just after the cell is capped is called the prepupal stage. During this stage the larva is still grub-like in appearance but stretches itself out lengthwise in the cell and spins a thin silken cocoon. Larvae remain pearly white, plump, and glistening during the prepupal stage.

***Pupae*.** Within the individual cells capped with a beeswax cover constructed by adult worker bees, the pre-pupae begin to change from their larval form to adult bees. Healthy pupae remain white and glistening during the initial stages of development, even though their bodies begin to take on adult forms. Compound eyes are the first feature that begin to take on color; changing from white to brownish-purple. Soon after this, the rest of the body begins to take on the color of an adult bee. New workers, queens, and drones emerge approximately 12, 7½, and 14½ days, respectively, after their cells are capped.

Brood Patterns

Healthy brood patterns are easily recognized when looking at capped brood. Frames of healthy capped worker brood normally have a solid pattern with few cells missed by the queen in her egg laying. Cappings are medium brown in color, convex, and without punctures. Because of developmental time, the ratio should be four times as many pupae as eggs and twice as many as larvae; drone brood is usually in patches around the margins of brood nest. Equipment needs vary with the size of your operation, number of colonies, and the type of honey you plan to produce. The basic equipment you need are the components of the hive, protective gear, smoker and hive tool, and the equipment you need for handling the honey crop. The hive is the man-made structure in which the honey bee colony lives. Over the years a wide variety of hives have been developed. Today most beekeepers in the United States use the Langstroth or modern ten-frame hive. A typical hive consists of a hive

stand, a bottom board with entrance cleat or reducer, a series of boxes or hive bodies with suspended frames containing foundation or comb, and inner and outer covers, next page, includes dimensions for those wishing to construct their own hives). The hive bodies that contain the brood nest may be separated from the honey supers (where the surplus honey is stored) with a queen excluder.

The Hive

***Hive stand*.** The hive stands, actually an optional piece of equipment, elevates the bottom board (floor) of the hive off the ground. In principle, this support reduces dampness in the hive, extends the life of the bottom board, and helps keep the front entrance free of grass and weeds. Hive stands may be concrete blocks, bricks, railroad ties, pallets, logs, or a commercially produced hive stand. A hive stand may support a single colony, two colonies, or a row of several colonies.

Hive stands

Bottom Board

The bottom board serves as the floor of the colony and as a takeoff and landing platform for foraging bees. Since the bottom board is open in the front, the colony should be tilted forward slightly to prevent rainwater from running into the hive. Bottom boards available from many bee supply dealers are reversible, providing either a 7⁄8- or 3⁄8-inch opening in front.

A Bottom Board

Hive Bodies

The standard ten-frame hive body is available in four common depths or heights. The full-depth hive body, 95⁄8 inches high, is most often used for brood rearing. These large units provide adequate space with minimum interruption for large solid brood areas. They also are suitable for honey supers. However, when filled with honey, they weigh over 60 pounds and are heavy to handle. The medium-depth super, sometimes called the Dadant or Illinois super, is 65⁄8 inches high. While this is the most convenient size for honey supers, it cannot be cut efficiently from standard-sized lumber. An intermediate size (75⁄8 inches) between the full- and medium-depth super is preferred by some beekeepers, especially those who make their own boxes. The shallow-depth super, 51⁄16 inches high, is the lightest unit to manipulate (about 35 pounds when filled with honey). This size has the greatest cost of assembly per square inch of usable comb space. Section comb honey supers, 45⁄8 inches high, hold either basswood section boxes or plastic rings and section holders. Section comb honey production is a specialized art requiring intense management and generally is not recommended for beginners. Some beekeepers prefer eight-frame hive bodies. However, using hive bodies similar in size permits the interchange of combs between the two hive bodies. Beekeepers who wish to avoid heavy full-depth hive bodies may elect to use three shallow hive bodies for the brood nest. This approach is certainly satisfactory, but it is also the most expensive and time consuming in assembly since it requires three boxes and thirty frames instead of two boxes and twenty frames.

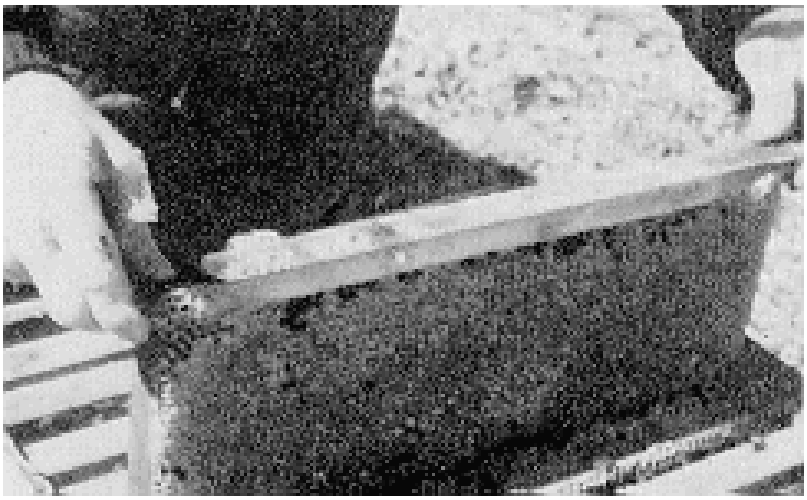
Frames and Combs

The suspended beeswax comb held within a frame is the basic structural component inside the hive. In a man-made hive, the wooden or plastic beeswax comb is started from a sheet of beeswax or plastic foundation. After the workers have added wax to draw out the foundation, the drawn cells are used for storage of honey and pollen or used for brood rearing. Frames are 17⅝ inches long and either 9⅛, 7¼, 6¼, or 5⅜ inches high to fit the various hive-body depths. Each frame consists of a top bar, two end bars, and a bottom bar. Top bars may be either grooved or wedged; bottom bars are split, solid, or grooved. Some types may have advantages over others, but the choice is generally a personal preference that includes consideration of cost. Top bars are suspended on ledges or rabbets in the ends of the hive body. V-shaped metal strips or metal frame spacers are often nailed on the recess for reinforcement. A popular commercial end bar has shoulders to help ensure correct bee space between adjacent frames and side of the box. The comb foundation consists of thin sheets of beeswax imprinted on each side with patterns of worker-sized cells. Two basic types of comb foundations are distinguished by their relative thickness: thin surplus foundation is used to produce section comb honey, chunk honey, or cut-comb honey; a thicker, heavier foundation should be used in the brood chamber and in frames for producing extracted honey. Thicker foundations often are reinforced with vertically embedded wires, thin sheets of plastic, metal edges, or nylon threads. When deciding whether to invest in plastic beeswax foundation in plastic frames versus pure beeswax foundation in wooden or plastic frames, initial cost, assembly time, durability, and length of expected use are all factors you should consider. Plastic foundation and frames are becoming increasingly popular. When using beeswax foundation in wooden frames, securing the foundation within the frame with either metal support pins or horizontal wires is necessary. The thin wedge of the top bar secures wire hooks extending from one side of the vertically wired foundation to help secure the foundation, ensuring that it remains in the center of the frame for proper drawing by the bees. Combs may be strengthened further by embedding horizontal wires (28 or 30 gauge) into the foundation with an electric current from a small transformer or by using a spur wire embedder. This activity is time consuming and difficult to master, but only a well-supported foundation results in well-drawn combs.

Swarming and Swarm Prevention

Swarming is the natural method of propagation for honey bee colonies. Natural selection has favored the maintenance of the swarming trait because those colonies that did not swarm died without leaving new

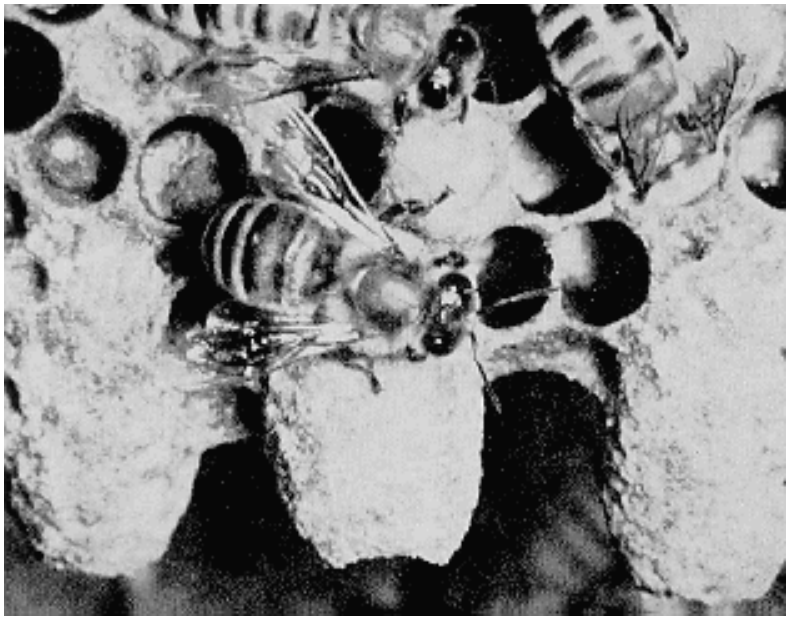
colonies to carry on. For centuries man has selected bees that produced the best swarms to increase the number of colonies. The use of movable frame hives now enables us to divide colonies at will, and we must try to prevent or control swarming because it weakens the colonies and reduces honey production.



Removing frame of honey from a well-provisioned colony.

A swarm consists of the old queen, some drones, and 50 to 90 percent of the worker bees of a colony. They leave the colony suddenly as a group and cluster temporarily on some object such as a tree branch. Later they disperse and move to a new home selected for them by scout bees. Sometimes several swarms from one hive leave over a period of a week or more, and many of them are accompanied by young, unmated queens. Queen cells are built in preparation for swarming, and the first swarm often leaves about the time the cells are sealed. Swarming is most common in the late spring and early summer periods. Many factors contribute to swarming. The most readily apparent one is crowding and lack of room for adult worker bees. In experiments on swarming, a colony put into a small hive swarmed in as short a time as 24 hours. Swarming is also associated with the amount and distribution of the glandular secretions of the queen. When there is a shortage of the secretions, the bees make queen cells in preparation for swarming or supersedure. Queen cells are also built in crowded colonies because of the unequal distribution of queen substances among the adult workers. Colonies with queens over a year old are more likely to swarm than those with young queens. The seasonal cycle of colony growth, the weather, and the heredity of the queen are additional factors related to swarming. The colony that becomes big early in the season is more likely to swarm than one that reaches its peak later. Swarming can rarely be prevented entirely but it can be reduced to a reasonable level by

good management. To reduce swarming you must plan ahead to provide your bees with young queens and sufficient hive space at all times. These measures will reduce but not solve the problem. You must also be able to recognize the signs that indicate a colony is making, or will soon make, preparations to swarm. One evident sign is a mass of bees that entirely fills the hive. They may come out of the hive in large numbers when you open it. A badly crowded colony often has bees clustered on the landing board and on the front of the hive near the entrance. During extremely hot weather such "hanging out" is an attempt to cool the hive and may not be related to crowding inside. Any crowded colony should be given one or more additional hive bodies filled with combs or foundation. The combs will do them the most good; foundation is of little value unless there is a nectar flow or the hive is being fed so that the bees can complete the comb. It is not unusual for a colony to occupy three or more deep bodies before the main nectar flow begins.



Unsealed queen cells built on the bottom edge of a comb in preparation for swarming.

Another warning sign of impending swarming is the condition of the queen-cell cups on the combs. They are always present but are usually short and small. The wax of the cups is the same color as the comb on which the cups are built. As soon as a colony begins preparation for swarming, the cell cups are enlarged, their edges are ex- tended and thinned, and new, white wax can be seen on the cups. The queen will lay an egg in the cup shortly after these preparations. When you find these conditions present, you must try to keep the colony from carrying out its plans. An additional super may solve the problem. If not, you can switch the location of the colony with a weaker one so that many of the

stronger colony's returning field bees will be lost to it. You can also remove sealed and emerging brood to add to weaker colonies. If nectar is coming into the hive, add one or more frames of foundation in place of the combs removed.

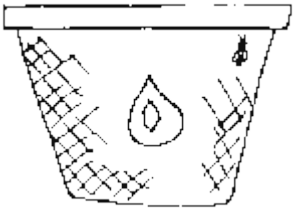
Prompt action is needed when you find large numbers of queen cells in a crowded colony. Check first to see if the queen is present and, if so, find and destroy all queen cells. Additional hive space may prevent a swarm from leaving, but more drastic measures have a better chance of success. For example, you can divide the colony into two smaller colonies or make one or more nucleus colonies from it. These techniques are explained on pages 101 to 102. There is little you can do for a colony after a swarm has left except to make sure that it has empty combs in which the new queen can lay.

Worker bees "hanging out" and fanning on the front of their hive because of the heat.

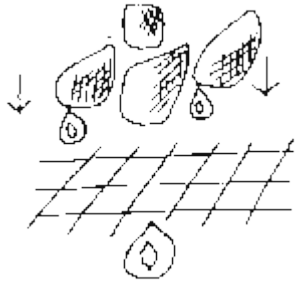
Harvesting of Honey

For harvesting honey, use combs that contain only honey and have at least two-thirds of the cells sealed. Preferably use only lighter-colored combs. Dark comb contains propolis, which can impart a strong taste to the honey. Using only honey comb prevents contamination from brood and minimizes the pollen in the final product.

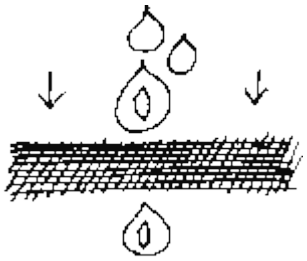
Removing honey from comb by pressing



1) Harvest only comb containing honey.



2) Cup up the comb or squeeze with hands. Strain through coarse strainer or screen wire.



3) Strain through fine material (cloth or screen).

4) Bottle and cap the honey

All honey contains some pollen. Too much pollen in honey is mostly an aesthetic concern. A high pollen content gives honey a cloudy appearance and can also give it a stronger taste. Pressed honey, or honey that is removed by squeezing it from the comb, has a higher pollen content than extracted honey. (Extracted honey is removed from the comb by centrifugal force. The liquid honey is spun out of the comb, and the solid pollen remains.)Water content is also important to the quality of the honey. All honey contains yeasts. To prevent the growth of the naturally-occurring yeasts and the subsequent fermentation of the honey, the water content of the honey should be below 19 per cent. Such honey is said to be mature or ripened. Nectar that has a water content above 19 per cent is called green or un-ripened honey. Yeasts cannot grow in ripe honey because of osmotic imbalance; there is no

water available to the yeast cells for growth. Once the bees have ripened the honey, they seal the cells of the comb. Use only honey comb that has most of the cells sealed for harvesting honey. This is the beekeeper's assurance that the honey is ripe and will be self-preserving. Ripe honey stored in closed containers in cool places will keep for long periods. it does not need refrigeration. Pressed honey is the type most easily produced in small-scale projects. To minimize the pollen content of the honey, check the comb for stored pollen before squeezing out the honey. (The pollen can be seen by looking through the comb toward the sun or a light.) Areas of comb that contain large amounts of pollen can be cut out. Remove the honey from the comb that contains pollen separately, and use it for home consumption. (The pollen and comb can also be eaten. Pollen is a nutritious food.) After the honey is removed from the combs, put it in a sealed container. Honey is hygroscopic; it absorbs moisture from the air. If left exposed in humid environments, the moisture content will rise and the honey will ferment. Dead bees or brood in honey can also raise the moisture content as well as aesthetically contaminate the honey.

Bees Wax

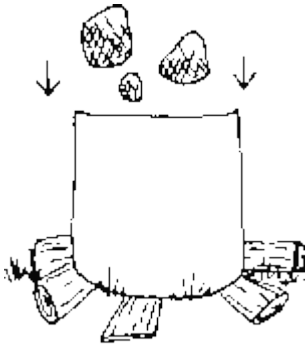
Is a hive product whose value is not recognized at all in some areas, while ' in others it is considered more valuable than honey. The wax of the western hive bee (*Apis mellifera*) differs from the beeswax produced by the Asian species of honey bee *(A. dorsata, A. florea*, and *A. cerana*). Wax of the Asian species is called Ghedda wax and is less desirable than that of the western hive bee for international marketing purposes. Pure beeswax is harder and has a higher melting point (64 degrees C) than most other waxes. These properties make it more desirable for certain applications. Beeswax is used industrially in cosmetics, pharmaceuticals, polishes, and candles. Uses for beeswax on a small scale include:

1. candle-making
2. lost-wax casting of metals
3. wax printing and batiking of cloth
4. polishes for wood and leather
5. strengthening and waterproofing thread for sewing
6. treatment of cracked hooves of domestic animals
7. making of comb foundation or wax starter ,-trips for beehives.

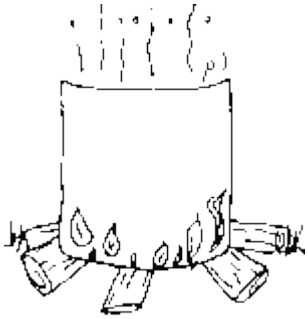
Many of these crafts and practices already exist, and can furnish a ready outlet for beeswax. Check with people engaged in these activities to find leads in developing a local market for beeswax. All old combs and pieces of wax should be saved for rendering into wax blocks. Old combs

should be rendered separately from newer ones since the newer combs yield a higher quality wax. Dark combs contain propolis and cocoons which lower the quality of the wax. Comb stored in pieces is highly susceptible to wax moth damage. With a solar wax melter, small pieces of comb can be rendered easily as they are cut from the hive and made into blocks. There is no need to accumulate a lot of comb to render at one time as is the case with rendering wax with hot water. Comb to be rendered can be stored for short periods in sealed plastic bags with moth balls (paradichloro-benzene or PDB) to prevent wax moth damage. Check the stored comb periodically for evidence of wax moth larvae. The PDB only prevents the adults from laying eggs, it does nothing to developing larvae. Stronger fumigants can be used, but these are generally impractical for small-farmers.

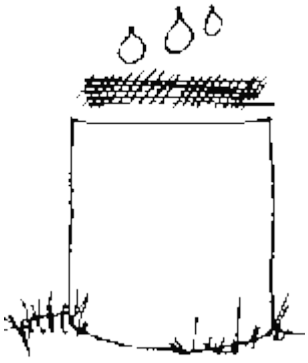
Rendering Wax - Method I



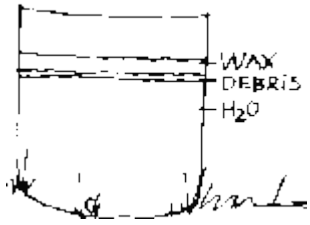
1) Put comb in pan of water.



2) Heat water until wax is melted (remember: do not boil! It's flammable!)

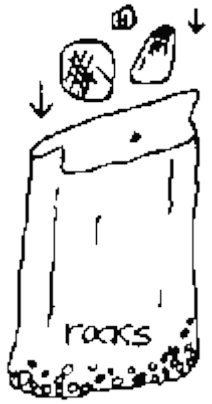


3) When melted, strain through screen.

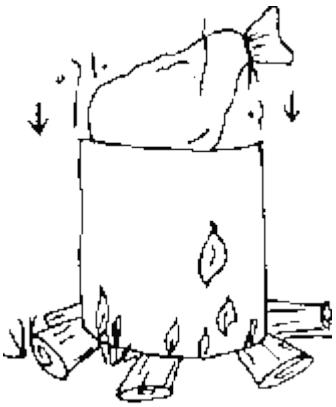


4) Leave this until wax hardens.
5) Remove wax block and scrape debris off bottom

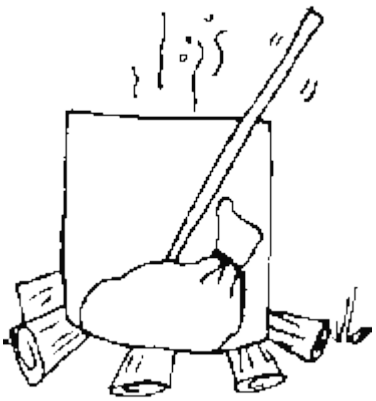
Rendering Wax - Method II



1) Put comb in burlap bag with rocks to weigh it down.



2) Put bag in hot water.



3) Stir bag around as wax is melting.

4) When wax is melted; set aside and allow the wax to harden.
5) Hot wax can be poured into molds, if desired.

Pollen: has only recently been thought of as a hive product for human consumption. Previously, it was collected by beekeepers during periods of heavy pollen flows and then fed to the colonies at the beginning of build-up periods to stimulate brood-rearing.The interest in pollen as human food is usually found only in large urban centers where there is a specialized market for natural foods. From a nutritional viewpoint, pollen is a rich source of proteins, vitamins, and minerals, though economically it cannot compete with conventional sources of these nutrients. The many medicinal claims for pollen have not be substantiated, and some people have even developed allergic reactions to ingested pollen. Pollen is collected by forcing the returning foragers to pass through a five-mesh (five holes per 2.5 cm) wire grid. The pollen pellets are scraped from the pollen baskets on the workers' hind legs and fall into a collecting tray covered with a smaller mesh wire to prevent the bees from retrieving the pollen. Several designs of pollen trap are used. Pollen collecting is not recommended for beginning or most small-scale beekeepers. The colony needs pollen to rear brood, thus only limited amounts can be removed or the colony will become weak. This entails monitoring the colony closely. Trapping pollen is more efficient in areas where there are intense flows. In most areas of the tropics, pollen collecting is difficult since the flows are weaker and the yields are low.Pollen also spoils quickly. The traps should be emptied often (daily in humid weather) to prevent pollen from molding. Once the pollen is collected, it must be quickly dried or frozen. Direct sunlight and too much heat reduce the nutritional value and quality of the pollen, thus special facilities are needed for processing and storage. The problems involved in collecting and processing pollen, coupled with its limited market, make it an impractical product for most small-scale beekeepers.

CHAPTER VI: ABUAD FARM AND FARMERS

RESEARCH AND EXTENSION LINKAGE IN NIGERIA; THE ROLE OF ABUAD FARMS IN REVOLUTIONALISING AGRICULTURE IN NIGERIA

Nigeria's economy traditionally was based on agriculture and trade, while agricultural extension had always been linked with agricultural development, pre-independence with success in the global commodity market. Farmers had always sourced for better seeds and breeds of animals for multiplication and enhanced food security through apprenticeship from the experienced-old farmers, for succeeding generations to adopt crop production, animal husbandry and soil management practices through observation and learners participation. The mandatory taxes to the colonial administrators compelled farmers to the productivity of cash crops ahead of food crops. The administrators bought at cheaper prices from farmers and resold at higher prices to foreign nations. The attraction of foreign gains from export crops led the colonial administrations to strive conscientiously to improve selective teaching practices of producing good varieties of food crops, tree crops and breeds of animals to farmers through extension services. This initiated the establishments of Department of Botanical Research in 1893, British Cotton growing Association in 1905, Department of Agriculture in Southern Nigeria in 1910, and its expansion in the North in 1912, Unified Department of Agriculture in 1921 and Niger Agricultural Project was founded in 1949 with the aims of producing groundnut as export and guinea corn for local consumption (Adesimi, 1995) amidst other agricultural development efforts for intensification and expansion of agricultural research activities. The post-colonial period witnessed better organization and coordination of public extension services funded by the government and international donors while private extension services is equally adopted without much outreach on farmers like the public extension system. Small holder farmers are the major key players in agriculture and rural economy of all developing nations, significantly in the sub-saharan African countries and other parts of Africa with their heavy reliance on rain-fed agriculture. These farmers grow marginally with low economic returns to low improved agricultural practices information, capital and accessibility to land for cultivation. The persistent indigenous knowledge of coping strategies with changing climatic conditions, and poor extension services to farmers often produce poor yield in agricultural production leading to exacerbating poverty condition and discouragement in farming among youth. Although, agriculture is still part of the Nigerian economy today with its vast contribution from subsistence farmers, sustaining the rural force

greatly and driving the rural youth from farming to other non-sustainable livelihood activities in the urban centres. However, the oil and gas sectors have taken over the agricultural sector's traditional function as the major source of foreign exchange earnings and highest contributor to Gross Domestic Product. Crude oil and natural gas account for about 15.0% of GDP, 71.0% of export earnings and 79.0% of government revenue while agriculture contributes only about 2.5% of export earnings (National Bureau of Statistics, 2012). Successive governments shortly after the discovery of oil in the 1970s have relegated agriculture to a secondary level behind oil and gas that are less sustainable. These developments have ceaselessly led to low productivity per unit of land and per worker, inadequate technology, environmental degradation, poor transportation and infrastructure, and trade restrictions by farmers.

The indispensable need for food production on a sustainable basis in the nation and an alternative to high unemployment rate through reliance on white collar jobs are still very much recognized and desire panacea, amidst all the odds. Agriculture holds great potential for household food security, improved rural livelihoods, employment opportunities for the population and alleviation of rural poverty. Nigeria is a vast agricultural country endowed with substantial natural resources which include: 68 million hectares of arable land; fresh water resources covering about 12 million hectares, 960 kilometers of coastline and an ecological diversity which enables the country to produce a wide variety of crops and livestock, forestry and fisheries products (Shaib, et. al., 1997). Agriculture remains a key component of Nigeria's economy, and currently contributes about 40.0% of the GDP and employing about 70.0% of the active population, the sector, the sector has however, significantly underperformed its potential (Federal Government of Nigeria, 2008).

Contrary to the country's huge agricultural potential, less than 50% of the total farmland in Nigeria is cultivated, and agricultural productivity is low because of the lack of modern farming, effective extension services and farmers capacity building system. Nigeria relies on the importation of food to meet its domestic demand, with the import bill for wheat, rice, sugar and fish estimated at1 trillion (USD 6.4 billion) per annum (Central Bank of Nigeria, 2012). The inadequacy of efficient diversification of the Nigerian economy and endless jostle for white collar jobs have resulted to a plague of very high food prices, food insecurity at the household and national level while social and political unrest is not left out. Agriculture can statutorily drive Nigeria's economy if adequately exploited, with the realization of excess food, agricultural raw materials, survival and sustenance of cottage industries for the teeming population, through

prompt and effective agricultural extension services in areas of innovative information on better agricultural practices, agricultural credit facilities and facilities for timely agricultural input delivery to farmers. The sustainability of agricultural production for basic wealth of the farming populace depends on timely and efficient technology, promptly disseminated to farmers in the country and Africa continent, to attain good managerial agricultural production. ABUAD farm has research laboratories and training hall in agriculture on the farm, where farmers and intending farmers are trained on profitable farming in the face of heightened dis-interest in agriculture among youth in the country. The rate of achievement of the linkage between agriculture and the industrial sector has remained sluggish in Nigeria. This is widely attributed to policy somersaults and the treatment of agriculture as a development programme hitherto the recent agricultural transformation agenda in the country, turning agriculture to a business enterprise. The inconsistent macro-economic policy initiatives in the country hinder many industrialists from patroniozing locally produced raw materials.

More than 65 percent of all businesses operating in the country are fuelled on agri-business which is primarily in the hands of the private sector where ABUAD farm plays a key role. Agriculture has shifted away from employing traditional practices to emerge as large-scale enterprises concentrating production in the hands of fewer larger players among which ABUAD farm exists and holds potential to supply corporate, capital intensive and farm-firm produce. Production methods employed to satisfy increasing demands of ABUAD's agricultural products include; the crop propagation options adopted for developing hybrid crops, use of weather station, cropping system and pests control measures adopted organisms that can stand the vagaries of weather conditions and give quality assurance of good harvest and sales of agricultural products to consumers. ABUAD farm produces locally, industrially and assist trained farmers on marketing of their produce by value chain of farm to fork. ABUAD utilizes non-residual agricultural chemical inputs as fertilizers, pesticides and herbicides to the importance attached to environmental friendly agricultural practice observed and passed to trained farmers for agricultural sustainability in Nigeria. Feed concentrates are made in the farm for aquaculture and other livestock operation and training is extended to farmers on income rewarding aquaculture and livestock production all year round. Agricultural machinery is sourced internationally and locally. Efficient locally made farm machinery are advised and sourced for financially non-buoyant trained farmers. ABUAD farm uses agriculture to create jobs, wealth and ensure food security in Nigeria. The farm employs subsidized prices for staff, students and communal people in order to enhance the interest of the

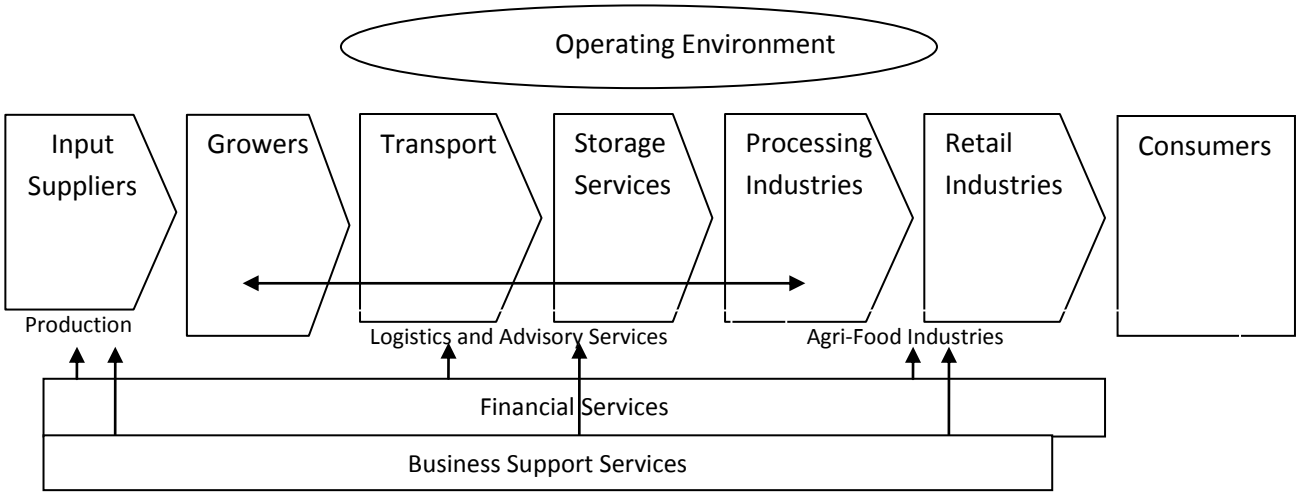
school and host community in agriculture essentially for community service and multiplier effect of farming as being venturesome to Nigerians and foreign people in the school. Afe Babalola University (ABUAD) needs encouragement from local and international agricultural development agencies to train and encourage rural farmers in Nigeria to advance their production of their arable, biennial and perennial crops, which will go a long way to reducing poverty, generate employment and make the farm a forest commercial centre for improved agricultural production training in Nigeria. However, there must be support drive towards economically efficient farm holding like ABUAD farm to extend training programmes as outreach programmes in rural communities to improve rural employment, rural income, rural development and growth. Leaders in local communities also, are looking for solutions to their local economic problems such as rural – urban drift that deprive the local communities of economic development. If rural areas cannot find ways to attract or create jobs requiring the skills of highly educated people, they will certainly loose the group most likely to be the catalyst for improving local social-economic conditions.

VALUE ADDITION TO AGRICULTURAL PRODUCTS FOR IMPROVED MARKETING

Value chains are catalysts that attract the market to pay for a good or service offered for sale appreciably. Raw materials processed into final agricultural products add value to the product at every stage along the value chain for buyer-driven interest at a very price. Value addition on agricultural produce offers revenue generation, employment generation along the value chain line in industries, efficient post harvest management and market competition for agricultural products. Small and Medium Enterprise business are down-stream industries with high reliance on agricultural raw materials for their operations, dominated by processors and retailers for presentation of acceptable market packages to the consumers. The Value Chain concept acknowledges that production must be linked to demand and the critical role of organizing the flow from farmer to consumer (Food and Agriculture Organization, 2012). Value addition can occur without high cost capital investment through engagement of the nation's research environment, encompassing the universities and research institutes with pro-active measures of research financing by the government and multi-national companies, formulation of research innovations to policies for adoption locally in the stance of very costly foreign technologies. It is is imperative to focus on sustainable and accessible business for the teeming unemployed youth using affordable technologies before diversifying into capital intensive value adding agro-processing technologies.

Investments in agro-food technologies will fail without adequate attention to sustainable management and empowerment systems having capacities that reduce operation costs.

Agricultural Value Chains



DIFFUSION AND ADOPTION OF INNOVATIONS TO FARMERS IN ABUAD FARM

One of the most important functions of extension is to bridge the gap between research centers and the farmers in the matter of introduction of improved methods of agriculture. Essentially, successful communication is the main job of an extension worker. An extension worker's job does not end by merely informing the farmers about improved practices, he needs to ensure practical application of the result of research and field trials by the farmers, themselves. Extension officer's efficiency can be measured (i) by the quickness with which the gap between what is known and what is done by the farmers is bridged. (ii) by the number of new practices adopted; and (iii) the number of farmers and communities that adopt the new practices. Afe Babalola farm engages facilitators that apply the under listed in their training and capacity building of trained farmers.

Innovation

It simply implies something new. The newness shows to some extent, a strangeness of the idea. To what extent is something really new? There are multiple answers to this query, answered within the confinement of time and space as it cuts across communities, states and continents. An innovation is therefore, an idea, practice or product that is perceived new by the potential users or adopters. Improved seed varieties, improved cropping practices, agro-chemicals and fertilizers are examples of agricultural innovations. Innovation and Technology are often used

synonymously. Technology is the application of knowledge for practical purposes. It is generally used to improve the human condition, state, position and natural environment by carrying out improved socio-economic activities than what obtains in the past. It can be said to be a complex mix of materials, processes and knowledge.

Types of Technology/ Innovation

Material technology: It is also known as hardware component (e.g) improved seeds, farm machinery, agro-chemicals, vaccines etc.

Knowledge technology: it is the technical knowledge and management skills such as planting dates, administration of agro-chemicals diluted in water applied to crops through the use of sprayers and other information that will help the farmer to increase his production.

Adoption: It is a decision to make full use of an innovation or technology as a best course of action available to an individual. It is a sequence of thoughts and actions which an individual goes through, before he finally adopts a new idea.

Adoption Process: It is the mental process through which an individual farmer or potential user of an idea passes from hearing about an innovation to final decision of taking up the innovation for usage. Adoption process occurs at individual level. Diffusion-It is a process by which an innovation is communicated through certain channels over time among the members of the social system. It is a process of information exchange or flow between two people, or among a group of people. It is special type of communication in that the messages are concerned with new ideas.

Diffusion Process: Diffusion process is the spread of a new idea from its source of invention or creation to its ultimate users or adopters.

Awareness: It is the acquaintance of an individual to an idea, information or technology.

Perception: It is the process by which an individual becomes aware of objects around him and the events taking place around him subjectively or objectively.

Adoption Process

An innovation diffuses within a social system through its adoption by individuals and group of people. The decision to adopt an innovation is

not an instantaneous act but a process over a period of time. The adoption process is a decision-making process, involving a series of mental stages before making a final decision is made to adopt an innovation. Decision making comprises a sequence of stages with a clearly different type of activity occurring during each stage of the mental process. Similarly, the way in which an individual adopts an innovation is related to events in a time sequence. The adoption process according to van den Ban and Hawkins (1996) consists of five stages or steps that an individual goes through in adopting an innovation. They are (1) Awareness (2) Interest (3) Evaluation (4) Trial and (5) Adoption.

Five Stages of Adoption Process

1. ***Awareness***: At this stage an individual hears, becomes aware of some new ideas to better productivity or turn-over rate of an activity, such as maize hybrid or new pesticide for farm production. He knows about the existence of the new idea but he lacks details about it. He may know only the name of a product as a productivity booster but lacks information on what it will do or how it will work.
2. ***Interest***: At the interest stage, a person wants more information about the idea or product. He wants to know what the idea is, how it works and what its potentials are. He may say to himself that this might help him increase his farm income, or help him control insects or diseases infestation on his crops or improve his living condition in some other way.
3. ***Evaluation***: At this stage, the individual makes mental application of the new idea to the present and anticipated future situations and decides whether or not to try and put it to test. He applies the information obtained in the earlier stages to his own situation. He then judges the worth of the innovation and make an assessment whether the idea is applicable to his own situation with resultant effect. He asks himself “can I do it? Do I have enough resources to try it? And if I do it, will it be better than what I am doing presently; will it increase my income or bring me better satisfaction?” The evaluation stage ends when an individual makes a decision to whether to reject or accept the innovation.
4. ***Trial***: The individual actually applies the new idea on a small scale in order to determine its utility and efficacy to his own situation. If he decides that the idea holds possibilities for him he will try it. The trial stage involves small-scale experimental use, and specific affirmation which deals with the relevance and usefulness of the innovation. The individual sees the prons and cons of his test and brings up resolution to use the idea subsequently or drop it. Trial

may be considered as the practical evaluation of the innovation. It provides evidence of the merits of the innovation.

5. ***Adoption***: This is the final stage in the process, when the individual applies the innovation on a large scale and continues to use it in preference to old methods or ideas conversant with. He achieves satisfaction with the new idea.

These five stages are not generally the patterned way of people's acceptance of innovation but cultural differences and social factors influence the affore-mentioned adoption process as most common practice to adoption process of innovation among people. At any stage the cycle can be thrown off and some people can jump from one stage to another outside the adoption process if or instance, the farmers have confidence in the extension worker, and his recommendations over time. Moreover, it does not mean that the adopter will continue to use the innovation for ever but tends to drop it when a better innovation comes on board or he has problem with the present innovation to some other reasons.

Innovation Characteristics that Affect Adoption of Innovation

There are characteristics of innovation which the prospective adopter considers and serve as encouragement to adopt an innovation quickly.

1. ***Relative advantage***: Is the degree to which an innovation is perceived by the adopter as being better than the idea the farmer is presently using. These may be measured in terms of profitability, low cost, time saving and immediacy of reward, convenience and satisfaction.
2. ***Compatibility***: Is the degree to which an innovation is perceived as consistent with the existing values, beliefs, past experiences and needs of potential adopters. Compatibility has at least two dimensions (a) situational compatibility and (b) cultural compatibility. When a new crop variety suits the agro-climatic condition of the farmer, it indicates situational compatibility. When a breed of livestock advocated to the farmer is in agreement with their beliefs and values, it is cultural compatibility. For example, piggery is a taboo to a devoted Muslim farmer.
3. **Complexity**: Is the degree to which an innovation is perceived as relatively difficult to understand and use. An innovation should, as far as possible, be very simple to assimilate and comprehend for usage. However, simple ideas or innovation are likely to be adopted more readily than the complex ones.
4. ***Triability***: Is the degree to which an innovation may be experimented with on a small basis. The fact that innovations hold

a degree of uncertainty, adopters usually consider the risk factor before deciding to use. The use of improved seeds or fertilizer can be tried on a small plot of the farmers' field without risking the immediate engagement of the innovation on the whole farm.

5. ***Divisibility***: It is the degree to which an innovation may be experimented with in small units, since innovations are not left out of uncertainty, adopters do consider the risk factor. Farmers or individuals as potential adopters need to try it out in bits before high adoption. For example, small quantity of improved seeds, fertilizers or herbicides could be purchased and used. However, this is not possible with the purchase of tractors or sprayers which is one time major investment and therefore, not divisible. Part of it cannot be bought or used in phases though it could be hired. Divisibility should not be confused with triability.
6. ***Observability***: is the degree to which the results of an innovation is visible and could be discussed with fellow farmers or other people. The visibility of the impact of an innovation facilitates its diffusion within a social system. For instance, the effect of the application of fertilizer to a rice plot can be easily noticed and convincing to any farmer who do not use.
7. ***Accessibility***: is the degree to which an innovation is readily available and affordable with minimum effort to an adopter.

It is very obvious from the issues raised above that farmers and potential ones have demands for innovations and therefore, the extent to which the farmer shows flexibility to innovation demands determines the level of his adoption. The capacity for the farmer to also adopt innovation is equally influenced by personal characteristics like age, education, socio-economic status, farm size etc.

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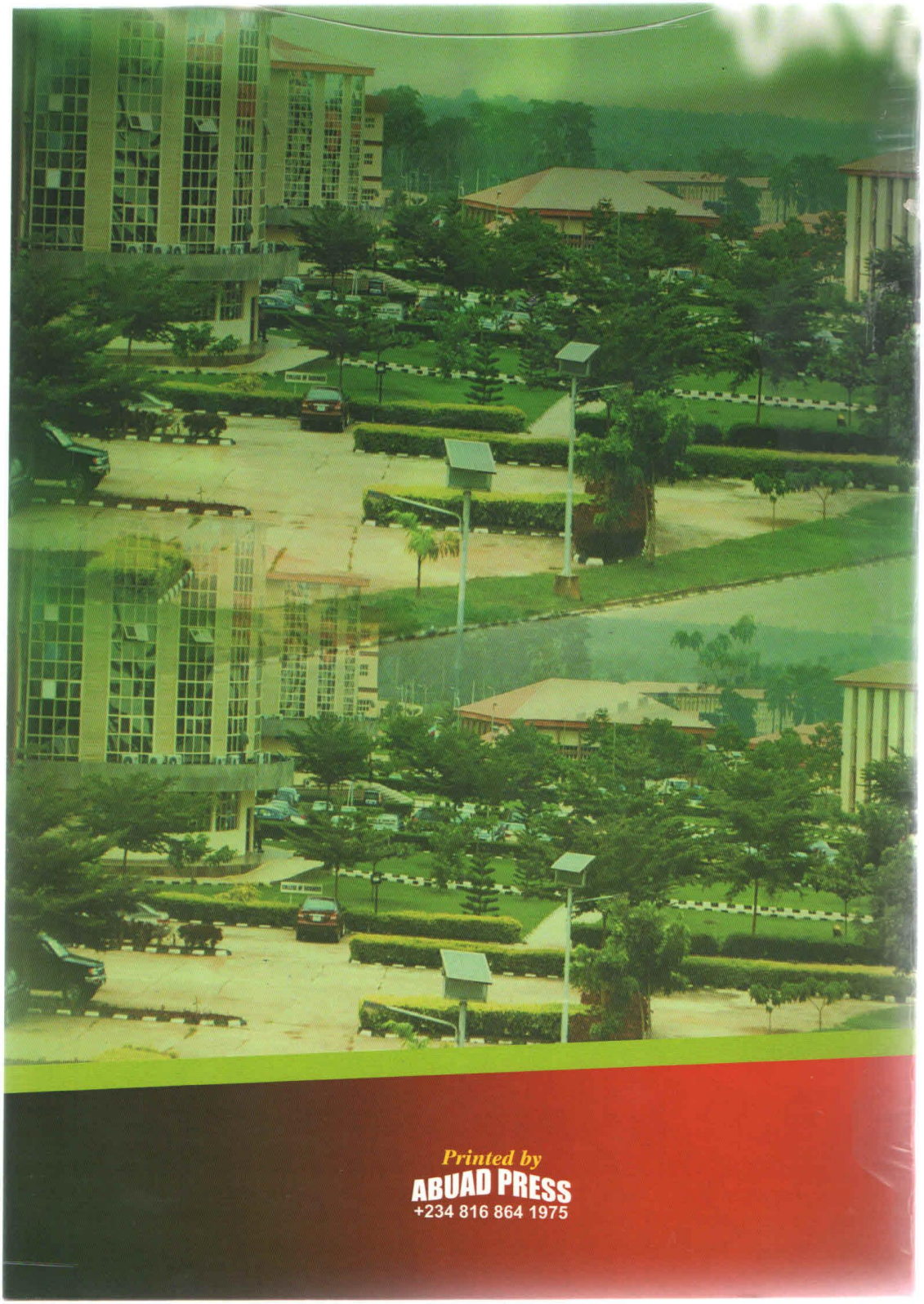
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