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Strategies for improving production and storage of kola in Nigeria

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ABSTRACT: Research on the improvement of productivity of kola is being carried out at the Cocoa Research Institute of Nigeria (CRIN), which has the mandate in Nigeria for research into production and extension aspects of Cocoa, Kola, Coffee, Cashew and Tea. Many constraints militates against the good management of large kola plantations, which includes incompatibility among trees, partial and total sterility, inefficient natural pollination, neglect of farms, decline in soil fertility and old age of most kola trees in existence coupled with both field and storage pests and diseases. These constraints are not without solutions as research activities at CRIN has evolved for improving production and storage of kolanut as highlighted in this presentation.

Key Words: Kolanut; *Cola acumilata*; *Cola nitida*; Storage conditions; Productivity improvement.

Introduction

In the forest areas of West Africa kola is perhaps second in importance only to the oil palm in the list of indigenous cash crops. *Cola acuminata* is considered as first choice in connection with social and religious ceremonies in the southern and middle-belt parts of Nigeria and the demand for it remains very high. *Cola nitida*, which is referred to as "the true kola of commerce", has featured in the internal trade of West Africa for a number of centuries (Nzekwu, 1961; Eijnatten, 1969).

Kola nuts are not common sight in Africa markets in cities and villages. They are often sold by street vendors at bus and train depots. Many Africans consume kola nuts regularly, even daily,for the medicinal, stimulating and sustaining properties. Kolanuts (*Cola acuminata* and *Cola nitida)* contain caffeine (2 to 3%) and smaller amounts of theobromin and kolanin, which dispel sleep, thirst and hunger and act as a stimulant and anti-depressant. They are also thought to reduce fatigue, aid digestion and work as an aphrodisiac. The nuts are nutritious, containing nearly 1% protein, 1.35% fats and 45% starch (FDA, 1973).

More recently, kola nuts and kola nut extracts have become popular in Europe and North America as a natural or alternative medicine. It also has industrial usage for the production of drugs, soft drinks, wines, candies and beverages. The pod husk can be used to replace 60% of maize in poultry feed formulation. It has other potential uses in the production of liquid soap and dyes (Beattie, 1970; Eka, 1971; Oguntuga, 1975a; 1975b; Famuyiwa, 1987; Egbe and Sobamiwa, 1989). Kola nuts are best known outside of Africa as an ingredient in cola beverages. Commercially produced cola drinks were developed in the late 1800s,

when chemists and inventors the world over used kola nuts (as well as other exotic ingredients) in various drinks and tonics. Coca-Cola, the most famous beverage in the world was invented from kola in 1886 by Atlanta druggist, Dr. John Smith Pemberton and marketed as a "brain and nerve tonic" (Prevention's Healthy Ideas, 2002).

The cultivation of *C. nitida* in Nigeria began in the 19th century (Eijnatten, 1969) and it is estimated that the country currently produces 88% of world's kola nuts with an annual production of 200,000 metric tonnes of fresh nuts, mostly from the Southern states on Nigeria (Jacob, 1973; Central Bank of Nigeria, 2002). Due to expected increase in the domestic chewing market for kola, increase in demand for exported nuts to meet the expansion of sales of "cola" beverages and other products containing kola nuts and expected demand for the by-products, following the recent discoveries of their potential industrial uses, the market prospects for kola are very good. But unfortunately, the production remains low because of many constraints. This presentation identifies the need to re-direct production efforts to meet the expected increases in demand and elaborates on the strategies for improving the production of kola in Nigeria.

Constraints of kola production

The Cocoa Research Institute of Nigeria (CRIN) in an effort to sustain the production of kola to meet the increasing demand; have identified the major agronomic factors that limit the yield of kola. These factors include; very low yield due to old age of trees, self and cross incompatibility among trees, partial and total sterility, inefficient natural pollination, field and storage pests and diseases.

1. ***Variability in kola:*** Kola exhibits tremendous amount of variability as outlined below.
   a. Variability in the number of trees that bear fruit in a given year: In a given kola plot the percentage of trees that bear fruit from year to year.
   b. Variation in production from tree to tree and from year to year on a given tree: This form variation occurs even among ramets (rooted cuttings)
   c. Auto incompatibility and varying degrees of cross incompatibility: While some trees are cross incompatible. It is known that 70-90% of kola trees in Nigeria are self-incompatible. When trees of the same incompatible group are planted together in the same plot, the yield of the plot is highly reduced.

2. ***Interspecific hybrids:*** The present generation of Nigerian kola was established largely from seedlings of interspecific hybrids: since the Nigerian farmer in selection of seed for planting paid no scrupulous attention. When *C. nitida* is cross pollinated with *C. acuminata* or vice versa, the nuts derived look exactly like the female parents in the cross; but when sown they often give rise to sterile trees. The widespread interplanting of both *C. nitida* and *C. acuminata* in Nigeria kola groves over the years is believed to have given rise to a high level of unproductivity, where 75% of the fruits are produced from 25% of the trees. The result is that the national average production is as low as 250 fresh nuts per tree per hectare.

3. ***Delay in flower initiation:*** Characteristically, the kola tree takes a long time to come to bearing. The age of bearing can be reduced by propagation through rooted cuttings. Flowering in *Cola nitida* seedlings may take between 3 to 7 years but is much shorter in rooted cuttings and may take a much longer time in *C. acuminata.* Nut production may range from 3,000 to 6,000 per tree per year and life span of kola may range from 60 -70 years.

4. ***Pollination in kola:*** Kola is by nature self-sterile. A kola tree may remain unproductive except it is pollinated through mechanical agencies such as man, animal or insects pest. Though kola trees are prolific in flowering, the natural pollination is known to be inefficient and only few fruits develop on the kola tree. There is also the additional problems of irregularity in flower production, flower drop, short pollen viability period and fruit abortion. Inefficient natural pollination can be improved by open hand pollination, which is capable of increasing the yield of a kola tree by about 20times. To carry out open pollination, the sepals and petals are removed from freshly opened male flower. The fused stamens, which carry the pollen grains, are held by the stalk and gently rubbed onto the stigmatic lobe of the flowers of the same tree or onto that of a neighbouring tree whose female flowers are compatible and within easy reach.

5. ***Long juvenile periods:*** The kola tree is known to display a long juvenile period sometimes lasting up to 10 years. Promising hybrids of improved *Cola nitida* (kola) have been developed; these hybrids produce in 5 years with an annual average yield of about 2,000 nut/tree/year marketable sizes (12-15g) compared with 250 nuts/tree/year of the unselected materials used by the farmers presently.

6. ***Pest problems:*** The role of insect pests, which are capable of destroying more than half of the little produced, cannot be overemphasized (Daramola, 1978a). These pest complexes were classified into major and minor pests depending on their damage patterns. The major pests of kola are weevils *Balanogastris kolae,* Desbr. And *Sophrorhinus* spp; the stem borer *Phosphorus virescens* Oliver; the fruit fly *Ceratitis colae Silv;* the pod borer *Characoma stictigrapta* Hmps; the leaf roller *Sylepta* spp and the defoliator *Anomis Leona* Schuas (Ndubuaku, 1989). The kola weevils *B. kolae* and *Sorphrorhinus* spp are the most destructive insect pest of kola. They are field-to-store pests. All trees in Africa are believed to be infested (Alibert and Mallamire, 1955) and the percentage infestation ranges from 30-100% (Daramola, 1973).

7. ***Disease problems:*** Many fungal diseases affect kola but the major ones, which pose serious threat to the production of the crop, are the root rot disease caused by *Armillaria mellea* and *Formes noxius* which also attack Cocoa and the complex of fungi attacking fresh and stored nuts.

i. ***Disease of fresh nuts***: This can be classified into three: internal rots, fresh rot and dry rot. Internal rot is caused by *Fusarium solani*. The cotyledons of infected nuts have an internally characteristic of grey rot while the outer surfaces look healthy. While for fresh rot, the causal agent is *Fusarium moniliforme.* At incipient of infection, colonies of fungal hyphae develop on the testa of the nuts followed by development of yellow patches on the older lesions. Harvested and unharvested nuts are affected. Dry rot, which is caused by *Furarium solani* is characterised by the development of greyish powdery crusts on the cotyledons. The affected areas eventually turn black and hard. Infection often starts from the outside and spreads inwards. Dry rot is a field-to-store disease affecting the fresh harvested nuts and stored nuts.

ii. ***Disease of stored nuts:*** Important disease of stored nuts include the dry rot, grey mould and black rot whose causal agents are *Fusarium solani, Boytritis sp* and *Botryodiplodia theobromae* respectively. Symptoms of the dry rot are as discussed for the fresh nut while for the grey mould, the nuts are covered with lesions having greyish and powdery mycelia. Grey mould is a serious disease of stored nuts, which spreads very rapidly from nut to nut. The black rot on the other hand, is characterized by a brownish black incrustation, which appear in the form of spots over the outer surface of the nut. Infected portions eventually turn charcoal black and hard.

Strategies for improvement of kola nut production

New technologies are high yielding plant materials have been developed to reduce the genetic, agronomic and pest problems of kola. More industrial uses of kola nuts and the by-products have also been developed to increase the local and foreign exchange earning power of kola. Highlights of some of the improvement strategies on kola are as follows:

1. **Planting material:** An improved kola planting materials can now be raised by using standard propagation techniques (seeds or vegetative means) developed by CRIN. Kola nuts show strong dormancy, therefore to ensure uniform germination; seeds for propagation should be harvested when completely mature and should be of large size. They should be uniformly cured (processed)and stored for up to 5 months. Seeds should be scarified to ensure faster germination. Kola seeds should be pre-germinated first in shaded seed boxes filled with moist sawdust. The nuts should be planted horizontally on their sides to a depth of 3cm below the surface, such that they are partially exposed. The nuts should be watered and covered with transparent polythene sheets. *Germination* is usually completed within 80 days *C. nitida* and 60days in *C. acuminata* (Opeke, 1992). The pre-germinated nuts are planted in baskets or poly bags filled with topsoil, at a depth of 7-10cm. They are adequately watered and kept under shade to develop in the nursery. The seedlings will reach transplanting size in 6-8 months. The shades be gradually removed as the seedling development progresses.

Vegetative propagation of kola trees has proven to be a practical proposition, especially for the multiplication of outstanding materials. Cutting for vegetative propagation should be taken from new

growth, which has just hardened, approximately two months after flushing. The cuttings should be from trees, which have proved to be high yielding. The cuttings are planted in concrete propagators or wooden boxes with a height of 60-75cm that allows sufficient space for the rooting medium. The cuttings should be 15-20cm long (Opeke, 1992; Adenikinju *et al*, 1989). Cuttings are to be collected when it is cool and humid, preferably in the mornings or late evenings, if the materials are collected from trees close to the propagator, it can be enclosed in polythene bag to prevent moisture loss. In case the cuttings are to be transported over long distances, they should be placed in a bucket, with their bases in water, and covered with polythene sheet. The cuttings should be transferred to the propagator as fast as possible. The few lower leaves on the cuttings are removed, together with any flower buds. The apical tuft of six or more is left. Subsequently, the cuttings are cut at the base with a sharp knife, under water, to provide a fresh clean surface and then they are placed, obliquely, in the rooting medium to a depth of 10cm. This should be followed immediately with intensive watering regime, but care should be taken not to waterlog the propagator.

The roots start to develop from callus tissues at the base of the cutting, on average nine weeks after setting (Opeke,1992). Successfully rooted cuttings are potted in rigid containers of at least 40cm high and 25cm wide in order to provide sufficient space for the new root. It is a must to use rigid containers because in flexible pots, the newly formed roots are likely to break as they are very brittle. The practice of potting cuttings in baskets, just like kola seedlings has been successfully perfected at the Cocoa Research Institute of Nigeria (Opeke, 1987; Adenikinju *et al*, 1989).

2. **New plantings and suitable soils for kola:** It is known that kola grows well in soils that are suitable for cocoa and coffee and in soils, which are marginal to these two crops and several other tree crops. Soil of inferior moisture retention and nutrient properties, which cannot sustain cocoa and coffee, can be utilized for kola decomposing rocks, deep soil profiles with a hard pan, areas liable to flooding or waterlogged clayey soils are all unsuitable for kola. There is an abundance of soils of high, medium to low fertility that can be strategically exploited for kola cultivation in an effective land utilization policy in Nigeria. Such suitable soils have long been identified in the following parts of the country according to FDA, 1973 and Opeke, 1992 as shown below:

- South-western states: (Most parts of the six South-western states)
- Edo state: (Most of the southern areas)
- Delta state (Most of the non-riverine areas)
- South-eastern states: (Most parts of the five South-eastern states)
- Cross-rivers state: (Most parts of the state)
- Akwa Ibom state: (Most parts of the state)
- Rivers state: (The non riverine areas)
- Kwara state: (Ilorin area)
- Kaduna state: (Zaria area)
- Adamawa state: (The southern parts of the state)
- Kano state: (Areas around rivers and streams if irrigation is provided especially during establishment stages)
- Niger state: (Mokwa and large areas of the upper part of River Niger provided irrigation is available)
- Benue/Plateau/Kogi states (Oturkpo and Karba areas)
- Nasarawa state (Lafia area).

3. **Rehabilitation of kola orchards:** One of the most important problem confronting production of kola in Nigeria is low productivity of existing old trees which can be attributed to poor farm maintenance, attacks of pests and diseases, neglect of farm, decline in soil fertility and old age. It is known that about 50% of the existing kola trees yield insignificant produce of 0-100 nuts per tree per year (Okoloko and Jacob, 1971). There is therefore large wastage of land in the kola industry especially in the western states. A more efficient utilization of land can be achieved by the cutting down of unproductive trees and replacing them with proven materials. Alternatively, old kola trees can be regenerated by coppicing at 30 – 60 cm ground level. The cut surface is immediately coated with red paint. The coppiced stumps start forming outgrowths or swelling from 2 to 3 weeks after coppicing. At about 3 months, buds start sprouting from the swelling and these develop into young shoots. Usually many shoots develop on the stumps and the

abundance of young growth attracts many insects but the shoots are partly protected by regular spraying of insecticide (Dimethoate). Coppicing should be done around July or December and the maximum percentage regeneration is reached between 9 and 12 months after coppicing.

4. **Harvesting:** Kola fruits usually mature in 4-5 months after pollination; at this stage, the fruit is inconspicuously brown and changes in colour from deep green to a paler tint. It is then ripe for picking. During the harvesting period, the under growth beneath the kola tree is removed to ensure that both harvested and fallen fruits can be easily collected. Ideally, the harvesting should be carried out before the pods begin to split and fall on the ground to guard against infestation by the kola weevils, *Balanogastris kolae* or *Sorphrorhinus Spp.* Harvesting should be carried out once or twice a month during the fruiting season beginning from September to the end of January. Sporadic fruiting often occurs in July/August, but the peak production periods is from October-December for *C.nitida* and April-June for *C. acuminata*. In a situation where the fruits are accessible during harvesting, they are harvested with a sharp cutlass, but where the fruit are out of easy reach (in case of tall trees), they are harvested with a hooked knife, Sickle or Go-To-Hell attached to a long bamboo.

The harvested fruits are gathered in a heap under the trees from which they are harvested and are later collected and removed to a central spot where the follicles are carefully cut open and the seeds extracted. From there they are carried in baskets to the village for skinning. The middlemen often purchase the pods or unskinned nuts at this stage.

5. **Processing and storage of kola nut:** Kola nuts are extracted from the pods and soaked in water or buried in most sand or made into lightly watered heaps for 24 hours to ease skinning. The skinned nuts are then washed and placed in unlined baskets, covered lightly with banana leaves and left for a few days (about 5) to 'sweat' – a process which reduces the water content of the nuts. The nuts are later placed in fresh leaf-lined baskets and covered lightly with leaves. Periodically, the nuts are stirred to prevent over-heating and to produce uniform curing. As the nuts are stirred, defective nuts (weeviled nut, mouldy nut etc.) are discarded. The curing takes about 3 weeks. Kola nuts cured in this way can be stored, if necessary, in baskets lined with fresh leaves or black nylon sheets and if the place is cool they will be kept for months without spoilage. All that is needed is occasional renewal of the leaves used to line the baskets. Kola nuts for export are usually sun-dried.

6. **Control of kola pests:** Only cultural methods are recommended for the control of kola weevils in storage. Use of pesticide are discouraged because the nuts are consumed in its raw form without further processing and the health hazards posed by the long term effects of pesticide residues on consumers is of concern to experts. Cultural practices involving early harvesting of mature kola pods, prompt removal of fallen and hanging mature pods at the end of the season, as well as the removal of dead and moribund pods between crops have been suggested as effective and economic methods of reducing the level of insect pest infestation in kola (Eijnatten, 1969; Daramola,1974; 1976; 1978a). Idowu and Ojelade (1994; 1995) observed that minimal level of weevil damage was recorded on kolanuts which were obtained from pods whose harvest were delayed (58.25% - 83.3%).

Other cultural control measures include destruction and proper disposal of all debris from the replacement of earthen floors at kola nut depots with cemented ones (Alibert and Mallamaire, 1955; Daramola and Taylor, 1975). Ndubuaka (2000) also advocated that since the kola weevil exhibit positive geotaxis, the farmers should concentrate on the physical removal of adult weevils from the bottom of the baskets and that the crevices at the bottom of the baskets should be thoroughly inspected during regular replacement of banana leaves to ensure that the weevils hiding at the bottom of baskets were not overlooked.

Hand picking and crushing of stem borers *P. viriscens* have been recommended by Squire (1964) and Gerard (1969). Ndubuaka (1987) observed that if the canopy of an infested kola tree is shaken or beaten, adult stem borers tend to drop to the ground and feign death. In the morning hours (7-11am) 50-85% will drop instead of fly, while in the afternoon, fewer adults (12-32%) will drop. Hand picking is therefore less labourious and more efficient as a control measure when carried out early in the morning. Daramola (1978a) and Ojo (1981) also recommended other cultural control methods such as poking of larvae of *P viriscens* in the tunnel with long wires or cutting and removal of stems containing the larva. The method was found to be effective even though it is labour intensive. According to Daramola (1978b), the

dehusking of pods far away from kola grooves and burying of pod husks which habour developing larvae will reduce the level of the kola pod borer *C. stictigrapta* population.

7. **Control of diseases of kola:** Control of the root rot disease of kola is by cutting and uprooting the infected trees and their subsequent removal from the plantation. On the other hand, control of the nut diseases is complicated by the nature of the crop and the condition under which it must be stored in order to retain its freshness. Chemical treatment of the nut is not advisable as they are eaten raw. However, use of Nitrogen gas gave effectively control of the storage fungi (Oludemokun, 1976), while a substantial reduction of post-harvest loss has been achieved in nuts stored in baskets lined with polyethylene sheet over banana or plantain leaves. Constant picking and destroying of affected nuts will also minimise infection. Soaking of nuts in solution of 1% sodium hypochlorite (Milton) immediately after skinning minimises microbial infestation of kola nuts (Agbeniyi and Fawole, 1999; Agbeniyi *et al*, 2000).

Discussion and Conclusion

Kola is an indigenous crop to West Africa unlike cocoa, cashew, coffee, tea, oil palm etc that can be traced to other continent as their ancestral origin. Also the only Research Institute in the world charged with kola development, improvement, marketing and publicity is the Cocoa Research Institute of Nigeria here in Ibadan, Nigeria. It is therefore our sole responsibility to uplift the standard of this crop to a level worthy of emulation by other countries and continents.

The benefits accruing from kola is quite enormous. The most famous beverage in the world, "Coca-cola" was invented from kola in 1886 by an Atlanta druggist, Dr. John Smith Pemberton and marketed as a "brain and nerve tonic". But for the fact that kola does not grow else where in the world outside Africa and the resolve for the imperialists to underdevelop Africa, Coca-cola abandoned real kola for synthetic kola chemical flavours. Till date they import their formulated concentrates from abroad to any of their bottling plants in African continent.

The resuscitation of this all-important crop occasionally referred to in some quarters as the "black gold" is in our hands. The government at the appropriate levels should speed up efforts in providing the necessary inputs, infrastructures and support services so as to remove the major constraints of kola production identified in this paper.

Research recommendations that are based on monocropping, oriented towards foreign farm practices, which are not based on the traditional farming system or which ignore an all-embracing farming system approach can also be constraints to kola production. This is because such recommendations do not make allowance for alternative sources of income, apart from sidetracking the age-long traditional practice of mix-cropping and intercropping and farmer's attitude to completely new recommendations. Research recommendation for kola production should therefore take into cognizance the culture and tradition of the farming community. Also, the adoption trails of such recommendations should be demonstrated to the farmers at designated demonstrations plots within their community. The Research Institute should always transfer their latest technologies and achievements to the farmers immediately rather than keep it in their shelves, as has been the case for years.

However, the research findings at the Cocoa Research Institute of Nigeria have tremendously reduced the genetic, agronomic and pest/disease problems associated with kola production. Improved and high yielding kola-planting materials with lower gestation period (5yrs) are now available for the establishment of new plantations. New technologies have also been developed on the utilization of the by-products of the crop. The appropriate application of the strategies suggested in this paper will no doubt transform to positive developments such as employment generation, rural development and a boost of the non-oil revenue base of the country and that of Africa in general.

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