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Agronomic practices of kolanut production in Nigeria

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ABSTRACT: The Cocoa Research Institute of Nigeria (CRIN) researchers have identified the major factors that limit the yield of kola. These factors include self and cross 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 pest and diseases. A major research achievement made at the Institute is the establishment of a kola germplasm with a number of promising hybrids, which are capable of producing in 5 years, with an annual average yield of about 2,000nuts/tree/annum (i.e. eight times the present national average production of 250 nuts/tree/annum). This presentation therefore elaborates on these factors that limit yield of kola and highlights the agronomic solutions to them with the sole aim of increasing the level of adoption of new technologies on kola production by farmers, which will definitely lead to several positive developments.

Key Words: Kolanut production; Agronomy; Crop yield; *Cola* sp.

Introduction

The genus *Cola* of the family Sterculiaceae (Russel, 1955), is indigenous to tropical Africa and has its centre of greatest diversity in West Africa. 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. About 40 *Cola* species have been described in West Africa, however, in Nigeria the *Cola* species of real importance are *C. acuminata* and *C. nitida* (Quarco, 1973; Daramola, 1978).

C. acuminata is used mainly in the southern and middle-belt provinces of Nigeria largely in connection with social and religious ceremonies which seems to have led to the tendency of many report underrate its importance. In the southern areas, *C. acuminata* nuts are still considered as first choice and the demand for them remains very high. *C. nitida* frequently referred to as "the true kola of commerce" has featured in the internal trade of West Africa for a number of centuries (Nzekwu, 1961; Eijinatten, 1969).

The kola nuts were used extensively, as a masticatory and stimulant, in the more arid savannah areas of West Africa (including Northern Nigeria) and throughout Central and North-central Africa, in recognition of their stimulating and sustaining properties. It is now known that kolanuts (*C. acuminata* and *C. nitida*) contain caffeine (2 to 3%) and smaller amounts of theobromin and kolanin, which dispel sleep, thirst and hunger. The nuts are also nutritious, containing nearly 1% protein, 1.35% fats and 45% starch (FDA, 1973). It also has industrial usage for the production of drugs, soft drinks, wines, candies and other potential uses in the production of livestock feeds, liquid soap and dyes (Beatie, 1970; Eka, 1971; Ogutuga, 1975a; 1975b; Famuyiwa, 1987; Egbe and Sobamiwa, 1989).

The cultivation of *C. nitida* in Nigeria began sometime in the 19th century. The "goro nut" (*C. nitida*) was observed to be "growing plentifully in the Otta bush" by 1854 while its cultivation was noted in Egba Division in 1902 and in Labochi and environs in 1901. From Agege, *C. nitida* cultivation presumably spread to theforest areas following, first, the course of the railway line into Abeokuta, Ibadan and Offa, replacing the local *C. acuminata* and penetrating, later, along streams and river banks into the Guinea Savannah and present South South and Eastern states (Eijinatten, 1969; FDA, 1973).

Nigeria accounts for about 70% of the total world production of Kola nuts (Quarco, 1969; 1973). While the demand is rising, the production remains low because many of the trees in Nigeria are unfruitful or have very low yield due to self and cross incompatibility among trees, partial and total sterility, inefficient natural pollination, old age of trees, field and storage pests and diseases (Odegbaro, 1973; Daramola, 1978; Jacob, 1971; 1973).

Soils suitable for kola production

Kola will respond well to fertile soils with a high organic matter content. Kola appears to be more tolerant of less favourable soils than several other tree crops. However, this should not lead to siting a new kola plantation in an obviously unsuitable area. Kola demands a deep, well-drained soil. The plantation site should have a deep soil profile into which the roots can penetrate and which allows the retention of water in the subsoil either by virtue of its depths or by its silt content. A shallow soil, decomposing rocks, deep soil profiles with a hard pan, areas liable to flooding or waterlogged clayey soils are all suitable for kola (Opeke, 1992).

Nursery Operations

(i) *Nursery site*: The nursery site should be near a stream. The nursery beds should be 1.2m wide and as long as convenient but separated by a path 45cm wide to facilitate weeding, watering and spraying. The beds should be provided with artificial shade whose density is adjustable.

(ii) *Propagation by seed*: This is the main method of propagating kola. To obtain the best results, nuts intended for use, as planting material should be harvested when completely mature and should be of large size. Since kolanuts show strong dormancy, to ensure uniform germination, seeds for propagation should be uniformly cured (processed) and stored for up to 5 months. Seeds should also 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 seeds should be watered and covered with transparent polythene sheets. Sowing may be done in November and transplanting in May or June. The nuts are then inspected weekly and as seedling development progresses, the shade should be gradually removed.

When the seeds have germinated and the roots attain the length of about 1.3 to 2.5cm, they should be gently removed from the germination boxes and planted into polythene pots already filled with rich top soil, taking care that the roots of the young seedlings are placed at the center of the polythene pot with the cotyledons placed half exposed on top of the potting medium. The polythene pots to be used should be 25 x 12.5 x 5cm with a hole at the bottom to ensure proper drainage. The shade should be reduced gradually before transplanting to the field in order to get seedlings hardened for the field conditions. Caterpillars, which are pests of kola in the nursery, may be controlled by hand picking. The seedlings may be transplanted to the field after 6 to 8 months but preferably at 9 to 18 months because old seedlings withstand the shock of transplanting better than the very young seedlings.

(iii) *Vegetative propagation*: vegetative propagation of kola is rather specialized. The practice is unlikely to be undertaken by the average farmer. The method is only briefly summarized here.

Vegetative propagation of kola may be by budding, grafting, marcotting or by rooting of cuttings. The last method is the most commonly used. Cuttings from semi-hardened flushes are taken in cool weather (as exists in the morning hours) and, if to be transported over long distances, are placed in a bucket with their

bases in water and covered on top with polythene sheeting. A fresh cut is made at the base with a sharp knife under water at the time of propagation and the cutting is immediately set obliquely in the rooting medium (usually sawdust) to a depth of 10cm. The cuttings are heavily watered and propagator is covered. Subsequently, the cuttings are watered thrice daily. The atmosphere surrounding the cuttings should be kept as humid as possible. Care must be taken to avoid water logging.

Roots begin to develop at the base of the cuttings in about nine weeks from setting. Rootedcuttingsare potted and subjected to 3 weeks hardening and then transferred to a shaded nursery.

Field Operations

Land preparation for planting: The method of land preparation used for kola establishment is very important. The following procedure will allow good development of kola plants as well as reduce the incidence of root diseases. The lands is first underbrushed. This is followed by felling of the understorey, and later the upper storey trees. The vegetation and stumps are left on the spot, traces are cut along future planting rows, and the felled vegetation is allowed to re-establish itself between the traces. As the plants develop, the re-growth vegetation is gradually cut back and finally eliminated. The labour requirements are also reasonable.

Spacing and planting procedure: The recommended spacing are 7.8m by 7.8m for *Cola nitida* and 3.6m by 3.6m for *C. acuminata*, which gives about 165 and 770 trees per hectare for *C. nitida* and *C. acuminata* respectively. Planting is done in 60 x 60 x 60cm.holes filled with good topsoil. For the first two years, following planting out in the field, the plants are heavily mulched and supplied with temporary shade of palm frond bipods. The number of weeding per year depends on the amount of rainfall.

Fertilizer practices: No standard fertilizer practices have been recommended for Kola. very little is known as of now, on the nutrient requirements of the crop. Pot experiments have shown that kola display the classical nutrient deficiency symptoms for the essential elements. However, field experiments have not revealed any advantages that are to be gained by orchard fertilization. The suggestion therefore is that fertilizer application be undertaken as the specific needs arises (FDA, 1973).

Flowering

Flowering in *Cola nitida* seedlings may take between 3 to 7 years but is much shorter rooted cuttings and may take a much longer time in *C. acuminata*. Nut production may range from 3,000to 6,000 per tree per year and life span of kola may range from 60 to 70 years. These flowers occur mixed in the same inflorescence: they are located towards the distal end of a leaf scar, usually on the smaller and mature flushes.

The flowers of *C. acuminata* are generally smaller than those of *C. nitida*. *Cola nitida* flowers between May and January and the flowers become more abundant in July and August, reaching a peak period of production in the middle of September and terminal period at about middle of December, followed by a negligible burst in January. *C. acuminata* flower between December to February; sporadic flowering may occur in August and September. In both species, the stamens of the flowers are not functional, and therefore self-pollination does not occur within the flower.

The male flower: This consists of 5 lobed perianth stamens, 2 rows of 10 numerous anthers. These anthers carry the pollen grains, which are yellow and sticky.

The female flower: This also consists of 5 lobed perianth, 5 curved fleshy stigmas lying over the ovary, at the base of which are 10 rudimentary stamens, there are 5 carpels which correspond to the number of stigmatic lobes.

Pollination in Kola

Kola is by nature self-sterile. A kola tree may unproductive except it is pollinated through mechanical agencies such as man, animal, insect pest. The flowers are both self and cross – incompatible. When

pollen grains from the stamen of one tree are transferred to the stigmatic lobe, of the same tree, it is referred to as self-pollination.

The process of pollination in kola may be classified into three:

(a) *Natural pollination*: Natural pollination is known to be inefficient and only few fruits develop on the kola tree. There are also the additional problems of irregularity in flower production, flower drop, short pollen viability period and fruit abortion. Also, little information is available on the species of the insect pollinators involved or the extent of their effectiveness.

(b) *Open hand 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 within easy reach.

(c) *Controlled hand pollination*: In this pollination, the female flowers are protected from contamination with foreign pollens by covering the racemes on which the flowers are about to open with waterproof paper bags prior to pollination. On the following day, when the flowers open, pollen grains from the same tree or from a neighbouring tree are dusted onto the stigmatic lobes of the female flowers. The pollinated flowers are kept bagged for about 3 to 4 days until the stigmas are no longer receptive.

Fruiting

When pollination is successful, fruits are set. The ovules open to form the star shaped kola fruits, which develop in a ring 3 – 5, rarely 6 ovules, hinged at right angles around the stalk. The ovules continue development until a period of 120 – 130 days when the fruits reach maturity. Fruits from *C. nitida* and *C. acuminata* vary in size and shape. They are described briefly below:

C. nitida: Fruits are egg-shaped but slightly bent upwards with the ends terminating in a curved beak. They are considerably shorter and more curved that *C. acuminata*: they measure 12.5cm – 15.1cm long and about 5.1cm – 7.6cm wide. They contain seeds with 2 cotyledons.

C. acuminata: Fruits are straight and slightly curved with a prominent straight point or tip. The surface is smooth and sometimes corky. They measure up to 20.4cm long and about 5.1 – 7.6cm wide. They also produce seeds with more than 2 cotyledons.

Kola fruits contain the seeds, which are between 10 and 14 arranged in double rows, these are protected by an elastic skin, which is the seed coat. Kola nuts vary in colour from dark to pure white. White nuts generally fetch a better price than coloured nuts in the trade. Colour of kola is hereditary character. To obtain white nuts, plant only white-nut kola trees, and ensure that there are no red trees within one kilometre from the white-nut trees.

Processing methods

Curing and Storage: Kola nuts are extracted from the pods and soaked in water or buried in moist 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 the leaves. Periodically, the nuts are stirred to prevent over-heating and to produce uniform curing. As the nuts are stirred, defective nuts (weeviled nuts, mouldy nuts, etc.) are sorted out and discarded. The curing takes about 3 weeks. Kola nuts cured in this was can be stored, if necessary, in baskets lined with fresh leaves and if the place is cool, they will keep for months without spoilage. All that is needed is occasional renewal of the leaves used to line the baskets. Exported kola nuts are usually sun-dried.

Desirable nut qualities: The most important factors, which determine the value of the kola nuts, are size, flavour, keeping quality and the colour of the nuts. White nuts are said to be superior to red and pink nuts in flavour, but flavour and keeping quality are ultimately determined by the method of curing and preservation. The following essentials determine the chewing quality of kola nuts.

(i) They should not be slimy;
(ii) They should not be astringently bitter in taste;
(iii) They should result in quick salivation when chewed;
(iv) They should be palatable and crisp.

Regeneration of old trees

One of the most important problems confronting production of kola in Nigeria is low productivity of existing old trees, which can be attributable to poor farm maintenance, attack by pests and diseases, neglect of farm, decline in soil fertility and old age. Up to 50% of the *Cola nitida* tree in Nigeria produce negligible yield of 0-100 nuts per tree per year (Okoloko and Jacob, 1971; Odegbaro, 1973).

Old kola trees can be regenerated by coppicing at 30-60cm ground level. The cut surface is immediately coated with red paint. No shade tree is planted near the coppiced trees. The coppiced stumps start forming outgrowths or swellings from 2 to 3 weeks after coppicing. At about 3 months, buds start sprouting from the swellings and these develop into young shoots. Usually many shoots develop on the stumps and the abundance of young growth attract many insects but the shoots are partly protected by regular spraying of insecticide (Dimethoate). The maximum percentage regeneration is reached between 9 and 12 months after coppicing, which should be done around July or December.

Diseases of Kola

Many fungal diseases affects kolabut 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.

Diseases of Fresh Nuts

(i) *Internal Rot*: This is caused by *Fusarium solani*. Internally, cotyledons infected have a characteristic grey rot while the outer surfaces look healthy.
(ii) Fresh rot*:* The causal agent is *Fusarium moniliforme v. subonitians*. At incipient infection, colony of fungal hyphae develops on the testa of the nuts followed by development of yellow patches on the older lesions. harvested and unharvested nuts are affected.
(iii) *Dry rot*: This is caused by *Fusarium solani* and 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.

Diseases of Stored Nuts

Important diseases of stored nuts include the dry rot, grey mould and black rot whose casual agent are *Fusarium solani, Botrytis* 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 characterised 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.

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 effective 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 of affected nuts and destroyer also minimised infection. Soaking of nuts in solution of 1.00%

sodium hypochlorite (Milton immediately after skinning gives 30% reduction in spoilage of nuts due to diseases (Agbeniyi and Fawole, 1999; Agbeniyi et al., 2000).

Pest of Kola and their control

Seventeen species of insect have been identified as pests of kola. The kola weevils are regarded as the major pest of the nuts. Losses due to insect pest ranged between 30-70%, and about 100% when harvesting is delayed. Cultural methods have been developed and recommended for reducing economically important field and storage pests of kola trees and kola nuts.

The major pests of kola are the weevils *Balanogastris kolae*, Desbr. and *Sophrorhinus* spp.; the stem borer *Phosphorus virescens* Olivier; 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 infected (Alibert and Mallamire, 1955) and the percentage infestation ranges from 30-100% (Daramola, 1973).

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. The cultural control methods include:

(a) Removal of fallen nuts/pods still on the trees at the end of main fruiting season and the unripe pods produced between crops.
(b) Destruction and proper disposal of all debris from the nuts and packing materials.
(c) Careful removal of all weevil-infected nuts before and during storage (Ndubuaku, 1988).

Production constraints in the management of large scale Kola plantations

The production constraints in the management of large kola plantations are listed below:

Interspecific hybrids: The present generation of Nigerian kola was established largely from seedlings of interspecific hybrids; since no scrupulous attention was paid by the Nigerian farmer in selection of seed for planting.

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 Nigerian 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.

Finance: Adequate finance is needed to provide working capital as well as initial capital outlay for large scale plantations. Availability of funds and provision of security or guarantee for loans can hamper the initial establishment of a large scale plantation more so as a lot of money would be required for land preparation, provision of seedlings, seeds and other inputs. Loan repayment conditions which do not take account of the long "gestation" period before tree crops begin to yield profits, can also constitute some constraints.

Market and remunerative price: Inaccessibility of markets due to their long distance, or due to bad road conditions and high cost of transportation can hamper the development of large scale plantations. Low and non-remunerative price for the produce of the plantation, transportation requirements for wholesale marketing of produce and the role of middlemen who come in as distributors under such circumstances can serve as disincentive to production.

Labour: The high cost of labour as well as its scarcity is a serious constraint to planting on a large scale. The scarcity of labour and high cost can be traced to the rural/urban labour migration and competition for labour with other sectors of the economy such as the industries and the production of other food crops.

Maintenance and weed control: Weed control at the initial stage of a plantation is extensive and labour intensive. Provision of adequate weed control may therefore constitute a major constraint due to the factor of labour scarcity and the inadequacy of funds to procure labour mentioned earlier. The execution of other intensive farm operations apart from weed control, are all year round operations which make maintenance of large scale plantations a big problem initially.

Land: The difficulties of acquiring large tracts of land for large-scale trees crop plantations, payment of compensation, the likelihood of litigations, are major constraints. The available small land holdings in the rural areas are held to tenaciously by the individual owners and are therefore difficult to combine into one piece to make a large plantation. Variability in the quality of land makes some large pieces of land unsuitable for large plantations.

harvesting, processing and storage: These are important operations closely tied up with maintenance, which also require labour and funds. Funds to provide processing and storage facilities in addition to labour for harvesting can constitute constraints to production.

Extension services: There are no well-organized extension services for kola in Nigeria. The Cocoa research Institute of Nigeria (CRIN), which also undertakes research on kola, supplies planting material to the various state of Agricultural Ministries, on request, for distribution to farmers. Field problems are also communicated to CRIN by the agricultural officers of the state Ministries of Agriculture through their Chief Agricultural Officers or Permanent Secretaries.

Provision of regular advice and up-to-date recommendations as well as assistance in obtaining inputs through the help of extension services are important factors to be considered in the establishment of large plantations. Their inadequacies can seriously hamper development.

research Recommendations: 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 (FSR) can also be constraints to production. This is because such recommendations do not make allowance for alternative sources of income, apart from side tracking the age-long traditional practice of mixed cropping and intercropping and farmers' attitude to completely new recommendations.

Government non-provision of infrastructures and supporting services: The provision of good roads, health services, water supply and electricity supply are the responsibilities of the government whether at federal, State or Local government level. These are matters usually outside the capability of individual plantation owners. These necessary infrastructures and services can constitute big production constraints in the rural areas as their non-provision encourages the migration of labour to the cities and makes it impossible to recruit skilled labour that will live in the rural area. Kola is yet to be granted an export status by the Federal Government of Nigeria, unlike Cocoa, Coffee, Cashew, Palm kernel, Palm oil etc. which enjoy favourable market prices in the International markets. The official enlistment of kola as one of Nigerians export crops will awaken the interest of farmers and encourage the establishment of more kola farms.

Mechanisation: There is a serious difficulty of mechanisation in tree crop plantations in the Tropics due to the high rainfall and difficult terrain. This can be a major constraint to production, especially where manpower cannot be used to carry out all farm operations. Also, the high rate for wear and tear as well as mechanical breakdowns under such conditions is a major problem.

Research achievements

A Kola germplasm has been established by the Cocoa Research Institute of Nigeria and a number of promising hybrids are now available which are capable of producing an average of 2,000 nuts/tree/annum, which is 8 times the present national average of 250 nuts/tree/annum. The Institute now possesses the largest and best Kola herbarium in the world. Apart from the genetic potential of kola, the various causes of low or non-productivity in Kola grooves have been identified and recommendations for improvement are available.

Conclusion

It is obvious that kola has numerous uses and the demand for the crop is high. The genetic, agronomic and pest problems of kola have been reduced through the research and development of new technologies and high yielding planting materials which can be sourced from Cocoa Research Institute of Nigeria (CRIN).

We therefore recommend that government at the appropriate levels should speed up efforts in providing the necessary infrastructures and supporting services so as to remove the major constraints of labour scarcity in the rural area; so that labour can be procured in quantity and quality. Also, the appropriate extension organs should find ways of providing incentives for the establishment of large-scale tree crop plantations. These constraints to production in the management of large-scale tree crop plantations should be removed where possible and minimized where complete elimination is not possible.

Further researches should be pursued more vigorously on the basis of farming System research and the existing age-long traditional farming practices; with a view to encouraging establishment of large-scale productive tree crop plantations by farmers. Adoption of the new technologies by farmers will lead to several positive developments such as employment generation, arrest of rural – urban drift of the populace, rural development, poverty alleviation, provisions of raw materials from the manufacturing industries and boosting of non-oil revenue for Nigeria.

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