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**ISSUES AND CONSTRAINTS RELATED TO THE
DEVELOPMENT OF CASHEW NUTS FROM FIVE
SELECTED AFRICAN COUNTRIES**

**(CÔTE D'IVOIRE, GHANA, GUINEA,
GUINEA BISSAU AND NIGERIA)**

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1. Introduction

The purpose of this paper is to give an overview of constraints and opportunities for cashew export development in five West African countries, namely Côte d'Ivoire, Ghana, Guinea Bissau, Guinea and Nigeria.

This paper is based on two surveys¹ conducted in 1999 and in 2001, and funded by the USAID, in the framework of the Sustainable Tree Crops Program (STCP). The aim of the Sustainable Tree Crops Program is “to improve the well-being of smallholder farmers, through the development of sustainable tree crop systems that increase productivity, generate income, conserve biodiversity, use natural resources in a sustainable manner and offer stable development prospects and long-term economic incentives”. The program focuses on 3 tree crops, namely cashew, cocoa and coffee.

Data for individual countries are only presented in the form of general conclusions, or with a view to illustrate a specific points, as much of the findings of the two studies are on the whole similar.

The two surveys were based on:

- The analysis of detailed questionnaires completed by various research institutes;
- Field visits made by the teams, during which thousands of trees were inspected and observed at the time of panicle production, flowering and nut set in different regions in the five countries surveyed. This time period was the most critical with regard to production of nuts and apples. It was also the time when pests and diseases were at their most damaging. Naturally there may have been other pests and diseases that occurred at other times of the year, but their effect would have been mainly on vegetative production. Fortunately cashew trees can withstand substantial damage to leaves, before there is a reduction in yield. It is also almost certain that pest populations will vary in intensity from year to year and place to place;
- Discussions with farmers, extension workers, processors, traders, etc.

2. Production constraints

2.1 Biotic constraints

❖ Insect pests

Damage from the different insect species, albeit at different levels of seriousness, was generally widespread throughout all the countries surveyed. Even though, perhaps, a particular insect pest species was not a problem in one country at the time of the survey, many insect pests have the

¹ “Assessment of Options and Opportunities for Tree Crop Development in East and West/Central Africa” by Dr. Clive P. Topper and Professor Peter Caligari, 1999, and “West Africa Regional Cashew Survey (covering the countries Guinea, Guinea Bissau, Cote d'Ivoire, Ghana and Nigeria), Volume 1”, by Dr. Clive P. Topper, Prof. Peter Caligari, Dr. Mahmoud Camara, Mr. Souret Diaora, Mr. Akadie Djaha, Dr. Felix Coulibaly, Dr. A. K. Asante, Dr. Adomako Boamah, Mr. E. Akin Ayodele, Mr. Patrick O. Adebola, 2001.

ability to move long distances, and could well become a pest in a new place in the future. In addition, as the area of cashew expands and increases, pest dynamics also change, often for the worse.

Sucking pests

***Helopeltis* sp** (Hemiptera: sub-order Heteroptera: family Miridae)

Helopeltis was present at many of the sites visited throughout Guinea, Guinea Bissau and Cote d'Ivoire. *Helopeltis* was also present in Ghana, but there *Anoplocnemis curvipes* damage was another common feature at some sites (see next section) and it was difficult to distinguish the relative importance of *Helopeltis*. In Nigeria *Helopeltis* was present but damage levels were very low.

Helopeltis was responsible for significant loss of yield at a number of sites, most notably in Guinea.

Helopeltis sucking pest leaf damage can take the form of black lesions on petioles or on the leaf midrib, or black angular spots on the leaf surface. Typical feeding damage on stems appears as a discoloured, necrotic area or lesion; similar lesions also occur on fruits and developing nuts. (People encountered during the course of the surveys were often identifying this type of damage as being caused by anthracnose.) When *Helopeltis* feeding pressure is sufficiently intense, the whole shoot dies and this damage is typically called 'Dieback' (see Photograph 1). In very serious cases, the entire tree looks burnt.

In East Africa, the sucking pests *Helopeltis anacardii*, *H. schoutedenii* and *Pseudotheraptus wayi* Brown (Hemiptera: Coreidae) are the main insect pests of cashew and studies there have shown that sucking pest damage can be very variable from year to year and place to place (Boma *et al.* 1998 and Topper *et al.* 1998). It is therefore, highly likely that *Helopeltis* damage in West Africa could vary in intensity from year to year and place to place, depending upon environmental factors, age and attractiveness of cashew and other host plants in the vicinity. In India, *Helopeltis antonii* (the tea mosquito) is the main production constraint.

***Anoplocnemis curvipes* (Hemiptera; sub-order Heteroptera; family Coreidae)**

Damage symptoms

A. curvipes are in the same sub-order of insects as *Helopeltis* and they feed in a similar way, by penetrating the living tissues of plants with their piercing mouthparts and imbibing the sap. (see Photograph 2).

A. curvipes damage (see Photographs 3 and 4) was found to be widespread in West Africa and was particularly serious in Cote d'Ivoire and Ghana, where farmers often wanted to spray in order to protect their cashew trees, but resources were not available.

According to Hill and Waller (1988), *A. curvipes* is distributed throughout Africa, where they suck the sap of a variety of plants including both sesame and coffee.

Thrips (Thysanoptera: Thripidae).

Many species of thrips exist and it is likely that more than one species could attack cashew in West Africa. The Plant Protection department in Guinea Bissau had identified *Selenothrips* sp. as one candidate.

The severity of attack by thrips usually varies from year to year and place to place and normally they are only dry season pests; as soon as the heavy rains start they disappear.

Damage symptoms

The vast majority of thrips species derive their nutriment by penetrating the living tissues of plants with their piercing mouthparts and imbibing the sap. Loss of sap can result in yield loss and some thrips species can transmit viral diseases. As a result of such feeding, mainly on the more mature cashew leaves, they turn a bronze colour and eventually drop off.

Thrips were widespread throughout the 5 countries surveyed; usually damage was minor and of no economic significance. However at a few places in Guinea and Ghana in particular, thrips were responsible for serious levels of defoliation and yield loss.

At the MIM Estate in Ghana, thrips and other sucking pests were a major problem. They have to spray 3 or 4 times every year to control the thrips; without this, the trees would be completely defoliated. Tractor-drawn sprayers were used, since backpack motorised blowers could not do the job. Interestingly, the trees from Indian seed were apparently more susceptible to damage from thrips than the local trees.

Trunk borers and girdlers

Evidence of trunk boring insects was seen at various places throughout the survey but the number of trees affected was small.

Apate terebrans (Coleoptera, family Bostrychidae)

The most spectacular example of borer damage was found in Seguela district, Cote d'Ivoire. In one 6 year old tree, **37** adult borers were found causing extreme damage and the death of the tree.

The following information was provided by the Natural History Museum (UK): "This species is widespread throughout Africa and Madagascar and has been introduced into Central and South America. The larvae develop in a variety of timbers, including living trees and construction wood. The adults also feed in the wood and they can damage young trees, causing death. The life cycle is usually 1 to 3 years depending on the condition of the wood, moisture content, extent of infestation, etc. Adult beetles will disperse naturally by flight but they have also been spread further by trade".

A. terebrans is polyphagous and Hill and Waller (1988) record *A. terebrans* as attacking coffee, citrus, cocoa, guava, cotton and other plants.

Cultural control is usually recommended, whereby a flexible wire (e.g. a bicycle spoke), is pushed into the tunnels to kill the larvae or adults. Insecticide-soaked cotton wool can also be pushed into the holes to kill the insect. Borer damage is usually restricted to a small number of trees, and with vigilance and the appropriate cultural control knowledge, it can be kept under control quite easily.

Analeptes trifasciata (Coleoptera, Cerambycidae)

Damage by this pest was mainly seen in Nigeria, but it has been reported as being a problem in all the countries surveyed.

Damage symptoms:

Damage to trees is quite characteristic, branches are completely girdled, with a V-section cut by the adult beetles. Only a small segment of the branch remains, which is too weak to hold the full weight and hence the branch eventually breaks off. The purpose of the girdling is to provide suitable breeding material for the larvae, in the form of dead wood. Eggs are laid on the cut branch and, on hatching, the larvae burrow into the wood. The adult is a typical “longicorn” beetle with attractive colour; it can reach a length of about 55mm and its antennae a further 70mm. The adult is generally black, with 3 bright orange coloured bands on the wing cases.

Lefebvre *et al* (1973) recommend the frequent spraying with insecticide to control this pest, but this is probably neither economic, nor desirable nowadays. The diligent, immediate removal and careful burning of girdled branches should help in the control of this pest.

Other insect pests

Other insect pests of minor importance have been seen, or mentioned by farmers, at the time of the survey. It should be noted that populations of many, even minor pest species, can fluctuate dramatically in response to changing environmental conditions and, in some years, can cause serious economic damage.

Aphids (Hemiptera; Aphididae)

Aphids were present at a few sites but were not economically important. There are many species within the Aphididae family and many are polyphagous, feeding on a range of crops and other non-crop plant species. When attacking cashew, they live on young shoots and foliage. Often the severity of aphid attack varies from year to year and place to place; with a heavy attack, shoots and panicles can be killed. Like thrips, aphids are usually a dry season pest, disappearing as soon as the heavy rains start. Aphids can be controlled naturally by a number of other insect predators and parasites.

Lepidoptera

Leaf miner and leaf roller damage were frequently seen, but were always of minor importance.

Termites

Termites were seen attacking one or two young trees during the course of the survey, and the termite *Coptofermes intermedius* (Isoptera, Rhinotermitidae) was listed as a pest by the Plant Protection Department in Guinea Bissau.

Mealybugs (Hemiptera, family Pseudococcidae)

Mealybug was seen only on two occasions. It was present on many panicles at one farm in Lafia, Nigeria, and on an isolated tree at the cashew processing factory at Korhogo, Cote d'Ivoire. It is worth mentioning that *Pseudococcus longispinus* is a serious pest in parts of Tanzania and Mozambique and it is very difficult to control.

From the literature

Pachnoda sp (Coleoptera, Scarabaeidae), noted in questionnaires from both Guinea and Nigeria as being a significant pest, was not seen during the field surveys.

❖ Non-insect pests

In Guinea and Guinea Bissau, squirrels were reported to be a pest, as they cut the stems of young cashew plants.

Birds or bats eating the apples and birds taking germinating seeds were also generally mentioned.

Although not normally referred to as a pest, cattle were certainly causing many problems for young cashew plants and farmers frequently reported this.

❖ Disease constraints

The two surveys were undertaken at the most critical time of year with regard to production of cashew, i.e. at the time of flowering and nut setting. Obviously diseases could be prevalent at other times of the year, for example during the rainy season, but are less likely to have a major impact on yield.

Anthracnose

Damage symptoms:

The fungus *Colletotrichum gleosporioides* is the causal agent of anthracnosis, a disease found on cashew and common on other tropical fruit crops, e.g. mango, citrus, avocado, papaya etc. Black or dark brown necrotic spots or lesions occur on leaves, apples and nuts. It is particularly prevalent during the rainy season and can completely kill the first flush of new shoots and persist to kill varying amounts of later flushes as well. The severity of the disease varies from year to year and place to place depending on environmental conditions.

Anthracnose is the major constraint to cashew production in Brazil. In the year 2000 it was estimated that yields had been reduced by 40% by this disease. In South America, anthracnose occurs on both dwarf and tall trees. Copper sprays are used to control anthracnose on dwarves with up to a maximum of 10 applications per season. Sanitation, the collecting up and burning of all old infected leaves, can help in reducing the level of inoculum the following year. Anthracnose can survive on the old leaves and in the soil.

During the one-off survey of West Africa conducted at the time of flowering/nut set in 2001, only very minor amounts of what looked like “fully developed” anthracnose were found in Guinea Bissau, Guinea and Cote d’Ivoire. In the production year 2001, in the areas visited in the five countries, anthracnose was of no economic importance. It should be noted, however, that this disease would be most prevalent during the rainy season. However, even if it was important during the rainy season, there appeared to be very little carry over into the dry season flowering period to attack panicles and developing fruits.

Therefore, it was concluded that anthracnose had no effect, or had only a minor effect on yields in 2001 in the main cashew producing areas visited. The drier areas further north, which was not visited, would be even less likely to have anthracnose. However, the conclusion that anthracnose was of minor economic importance, at least in 2001, is in marked contrast with the perceived understanding of the situation by people working in the countries concerned. From discussions with various researchers, extension workers, as well as from literature and completed questionnaires, it appeared that anthracnose was an economically significant constraint to cashew production in West Africa.

This issue needs therefore clarification and further work. Two possibilities could explain this apparent contradiction:

- Due to differing environmental conditions in other years, anthracnose has in fact been more of a problem in the past, and could be in the future;
- Field workers have confused other types of damage for anthracnose, leading to mis-identification (during the survey, other types of insect damage were attributed to anthracnose in a number of occasions).

A certain type of disease found to be quite prevalent in the Dabola/Kankan area of Guinea and around Odienne, in Côte d'Ivoire, further confused the situation. This disease that was found only on leaves, was initially thought to be the rust coloured algae *Cephaleuros virescens* at various stages of development. Leaf samples with this disease were sent to the International Mycological Institute (IMI) in UK, which identified *Colletotrichum gleosporioides* (*Glomerella cingulata*) and *Phomopsis anacardii*.

There are a number of possible explanations:

- *Colletotrichum gleosporioides*, which is common in the soil and on other plants was present on the leaf, but was not active or pathogenic to the cashew leaf (i.e. accidentally present)
- The genus *Glomerella cingulata* contains saprophytic strains, and hence could have been present as a secondary infection, i.e. it was feeding off dead tissue caused by a previous pathogen
- Pathogenic *Colletotrichum gleosporioides* could have been present before, but due to unfavourable weather conditions it did not develop fully.

More work in this area is required.

In East Africa, where powdery mildew disease is the main disease constraint, there is a very low incidence of anthracnose. It only affects a very small percentage of panicles on a very small number of trees, hence, very little work has been undertaken on the problem there. Since the introduction of Brazilian dwarfs, anthracnose has become a more noticeable problem, but it is still mainly confined to dwarf trees (e.g. in Mozambique at Monapo, Itoculo and recently at Nassuruma). The situation at Itoculo was so bad, that most of the dwarf trees were cut down in an attempt to control the disease. However, the fact that the disease had spread to local tall trees was more worrying.

It can be assumed that, since common tall trees in Brazil are very susceptible to anthracnose, tall trees in both West and East Africa will be similarly susceptible, since the African trees originated from Brazil many years ago. The fact that the disease has not become established in East and West Africa could be attributed to environmental, cultural or other reasons. However, strict quarantine regulations must be maintained or instigated, if they are not already in place, when planting material is imported, especially from outside the region.

Cephaleuros virescens (red or rust coloured algae)

This algae was identified by IMI from cashew leaves collected from the Accra region of Ghana, during a visit in May 2000, and seen at various locations during the survey. This algae is a common parasite of evergreen perennial crops and is not considered to be a constraint to cashew production.

Powdery Mildew Disease (PMD)

During the dry season (January/February) in West Africa, when the surveys took place, climatic conditions and the availability of suitable young host tissue are both ideal for PMD. Therefore, if PMD would have been present, then it was the time when it would be at its most intense. However, of the many hundreds of trees and thousands of panicles inspected, PMD was not found on any of them.

Somewhat in contradiction to these observations, PMD was second on the list of the most important diseases on cashew according to the Plant Protection Department in Guinea Bissau, while Camara and Vayssie (1996) list PMD as one of the principle diseases in Guinea Bissau.

For reference PMD is described as follows, for reference: “The most serious biological constraint to cashew production in East and Southern Africa is powdery mildew disease, *Oidium anacardii*, first described by Noack in 1898. It is also found in Brazil, but there it appears to attack older, more mature plant tissue while in East Africa it only attacks new, actively growing tissue. In East Africa, PMD develops on young growing tissue, e.g. new shoots with tender leaves, panicles from the very young to the mature, apples and young nuts. Infected parts look as though they are covered in a white/grey powder. Severely infected young leaves change colour from green to brown, become deformed and eventually drop off prematurely. Mature older leaves with a well-developed cuticle are not attacked. Production can be severely reduced when PMD attacks young panicles and flowers. Infection can occur even before buds open on young panicles; often the pedicel (stalk of an individual flower of an inflorescence) is attacked; it becomes necrotic and causes the flower to abscise. Badly infected panicles where buds have abscised appear stunted and grey in colour. Infected apples lose their bright colours, becoming cracked and shrivelled as they dry up. Young infected nuts may abort; those that manage to mature become tarnished and dull in colour; nut weight and percentage out-turn are both negatively affected”.

Conclusions regarding pests and diseases

Extensive observations made during the survey would suggest that insect pest damage is of much greater significance than disease problems. Diseases were of minor importance, but it should be noted that this might not always be the case. As the area of cashew expands, the likelihood of major disease problems also increases. It should be remembered that in East Africa up until the early to mid 1970s, when cashew nut production nearly reached 400,000 tons, PMD was not important. Now it devastates production throughout the region. There is therefore always a need to be vigilant about diseases in order to prevent them getting a firm hold.

The issue of anthracnose needs further clarification.

The two Hemiptera sucking pests *Helopeltis sp* and *Anoplocnemis curvipes* (both sub-order Heteroptera), and thrips, are probably the most economically damaging pests over the region in general. Trunk borers (*Apate terebrans*, Coleoptera, family Bostrychidae) and branch girdlers (*Analeptes trifasciata*, Coleoptera, Cerambycidae) can be serious on a more isolated scale. There are also a number of minor pests in the region as a whole, which could be serious sporadically or from time to time (e.g. Aphids, leaf rollers, etc.).

There is an urgent need for quantitative data on the economic status of pests and diseases, including:

- The distribution of pests and diseases in each country
- The frequency and intensity of damage caused

- The loss of farmer income due to the different pests and diseases

It would be useful if the collection of such data could be harmonised, co-ordinated and jointly analysed across the region. Such region-wide data would be of greater value than the sum of the parts.

Knowledge of cashew pests and diseases was generally very limited among field workers.

2.2 Environmental constraints

'Natural' drying of flowers

Panicles can dry out naturally, to give a perfectly formed flowering panicle, which is brown in colour and devoid of potentially useful nuts.

Although entire trees are often affected, this particular problem is not caused by a disease. The presence of dried flowers was seen quite frequently and reported as a problem by a number of farmers. In Nigeria, the harmattan was blamed for a number of problems, but the drying of flowers was the most frequently mentioned by farmers. However, in one location it was apparent that the seriousness of dried flowers could vary dramatically from tree to tree. Sardinha *et al* (1993) reported that in Guinea Bissau, ... "since it is well known the negative impact in cashew yield (by affecting its fertilisation) of the dry wind spells from the Sahara, that normally occurs from 10-30 April, one selection criteria must be set to choose those clones or lines that show early blossom period." The problem of flowers drying out and giving no production is sufficiently serious and widespread to warrant further immediate research.

Natural drying of panicles can be a serious problem in East Africa in some areas or years. Little research has been done on this problem but the possible causes could be genetic, environmental, lack of pollination, rainfall during flowering or nutrient deficiency.

Nutrient deficiencies

Symptoms of nutrient deficiencies were seen only occasionally, and the symptoms displayed were similar at all sites – mottled (like marble) yellow and green leaves. This was thought to possibly be a nitrogen and/or zinc deficiency, but a precise diagnosis would require leaf and soil analyses.

Fire

Fire was probably the major cause of lost cashew production in West Africa, and was frequently reported by farmers as one of their major problems in all countries visited. Fires do not only reduce yields in the year of the fire, but also cause reduction of yield in the subsequent years, deform the tree and, in some cases, kill trees outright.

Various reasons were given for why fires were started, such as: to enable the hunting of small mammals; accidentally; because of grudges; to increase new grass for cattle; or to remove weeds for land preparation. Annual crop farmers and herders have no interest in the problem. However, it has been demonstrated that as a 'cashew culture' develops with more and more farmers growing cashew, fires are more likely to be brought automatically under control.

In addition to the direct impact of fires on farms and estates, with or without cashew, there is an enormous environmental cost to the bush fires that rage across large areas, whether it is farm land or not. Not only are crops, trees and grasses destroyed, but the valuable topsoil can also be eroded, leaving less and less fertile land. Annual bush fires contribute to a decline in biodiversity and biomass, release a considerable amount of CO₂ to the atmosphere, and so contribute to global warming. Various human activities, such as the burning of fossil fuels, deforestation, grassland conversion and other land use changes, have contributed to large increases in the level of carbon dioxide and other greenhouse gases in the atmosphere, which are thought to be responsible for global warming. Most experts now agree that if this trend of global warming continues, the global consequences could well be substantial and worst affected could be Africa.

Overcrowding of trees

Cashew trees were over-crowded on many of the farms visited. Spacing was sometimes down to as little as three meters. The reason for such close spacing of trees was connected with the planting of cashew as a forestry crop for environmental purposes. Even when farmers planted cashew for commercial reasons, they still planted at high density because they didn't know more about optimum planting distances for nut production.

An interesting example was from a farm in Seguela district, Cote d'Ivoire. The farm was 3.75 ha in size and was planted closely spaced over the years 1987, 1988 and 1989. The plot started to yield after 3 years and in 2000 it produced 3 tons from 3.75ha, in spite of the fact that the trees were over-crowded.

Because the canopy was contiguous there were no weeds. The farmer only had to control the weeds around the periphery of the plot where fire from outside was still a problem. With fire being such a problem in cashew orchards (due to the presence of weeds), and labour to control the weeds being either in short supply or expensive, it might be more economic to plant cashew at high density. This keeps the weeds down, reduces the risk of fire damage and minimises labour costs, although on the negative side, yields are lower. This might be acceptable if the following conditions apply:

- land is plentiful,
- labour is limited and/or expensive
- diseases are of little importance (high density planting often exacerbates disease problems)
- insect pest problems are not made worse by high-density cashew trees.
- fire is often a problem.

A number of farmers commented that they preferred a dense cashew stand, in order to not have to weed. When more quantitative data is available, a rigorous economic analysis should be done on high versus normal density planting. It is also extremely important to bear in mind that a dense canopy makes it very difficult to achieve good overall coverage of each tree with insecticide or fungicide, should application of these be required.

Conclusions regarding environmental constraints

The problem of flowers drying out resulting in no production is sufficiently serious and widespread to warrant immediate research. Progress on this topic could be made relatively quickly, at least to the point of narrowing down the number of factors that might be responsible.

Obvious cashew growth deficiencies are not a major problem (unless linked to drying of flowers) and although there is work to be done in this area, it is not a high priority.

Bush fires and the subsequent damage to cashew is one of the major constraints to cashew production at the moment. A comprehensive review of the literature needs to be undertaken to see what approaches have been adopted in other parts of the world, and for other crops, to determine how this can be applied to cashew, a crop that fruits towards the end of the dry season when fires are at their most devastating.

Cashew has a very valuable role to play in bush fire reduction in general, because it yields in the dry season. Experience in other countries has shown that as a 'cashew culture' develops, with more and more farmers growing cashew, fires are almost automatically brought under control.

A closer look at the economics of high density planting is required and should be undertaken in all the countries, since yield potentials and input costs (such as labour for weeding), will vary considerably.

2.3 Constraints related to breeding, planting material and research

The previous section gave a realistic picture of the major biotic and environmental constraints to cashew production in the region, on which breeders can start selecting resistant or tolerant types, in addition to the normal characteristics of good yield and quality.

There follows a brief review of existing germplasm and what breeding work has been carried out in individual countries.

❖ Guinea

The "original" germplasm collection at CRAF (Centre de Recherche Agronomique de Foulaya) was a group of sixty-one old trees, planted as seed in the 1950s. Although originally planted at a good spacing, the trees are now somewhat over-crowded. The source of these trees is unknown, although Tanzania and Mozambique have been suggested as possibilities. The reason for their selection is also unknown; at the time of planting their purpose might have been for forestry, or just to have cashew on the research station for student studies. Characterisation of nuts from these trees has started.

A second germplasm collection at Kankan consisted of seed from some of the original Foulaya collection and seed from a few selected trees in the region. These trees were planted very recently, in 1998 and 1999. There were no replicates and the researchers did not know how many trees were surviving (although this appeared to be low).

The only new plant material of known provenance recently introduced into Guinea was seed from Brazilian clones CCP 09, CCP 1001 and CCP 076. Unfortunately, only small percentages have germinated. These seeds were imported without any quarantine procedures. This is potentially very dangerous, as Brazil has cashew pests and diseases that are not found in West Africa. Before importing more cashew seeds from other countries, especially outside of West Africa, suitable quarantine procedures must be put into place.

A new germplasm trial at Boke has been planted from seed, and so all the new plants were half-siblings and not clones of the original mother trees. New material included seed from:

- the best trees in the "original" collection,

- selected mother trees from Boke region,
- Brazilian seed originating from a forestry project (nothing more is known about this source).

At Foulaya, research technicians have started practising grafting cashew plants. However, so far all germplasm material planted has been derived from seed; no vegetatively produced seedlings have been used.

There was confusion amongst some people as to why trees grown from seed were called half-siblings and not clones, and also about what constitutes a clone.

❖ Guinea Bissau

Local researchers contacted were not aware of any imported planting material (it was suggested that the company Agri-Bissau had imported seed from Brazil, but this was not the case). A USAID funded project wanted to import cashew from Brazil, but this was refused on quarantine grounds.

Farmers were planting local seed and some were selecting on the basis of nut size. ADDP (an NGO from Denmark) was also selecting local seed for planting based on nut size.

In 1994 and 1995, the Agri-Bissau estate selected seed for planting from an old plantation at Quihamel. Since then they have selected seed from their own plantation. The criteria for selection of seed were nut weight, tree structure and intensive branching.

Agri-Bissau was experimenting with side grafting of precocious trees. Apart from this very minor experimental testing, there appeared to be no practical use made of vegetative propagation techniques in Guinea Bissau.

The reports by Camara and Vayssie (1996 and 1997) provide considerable information about nut-weight data, some of which is summarised in the following table.

Percentage distribution of raw nut weights from Guinea Bissau

Category	Cajui	Très petites	Petites	Moyennes	Grandes	Très grandes
Weight range	<3.35g	3.36-4.50g	4.51-7.00g	7.01-10.00g	10.01-15.00g	>15.00g
1995/96	10	32	51	7	0	0
1996/97	6	28	54	12	0	0
Average	8	30	52.5	9.5	0	0

Source: Data from Camara and Vayssie (1997)

Data in the table show that from the average of the two seasons' samples, 38% of nuts, i.e the grade termed "très petites" (very small) weighed less than 4.5g. Moreover, around 60% of raw nuts weighed less than 5.00g.

The fact that nuts from Guinea Bissau are generally small was also reported at the 2001 World Cashew Congress in India and yet, in spite of their small size, they command a premium on the international market. The reason for this is the high percentage kernels out-turn of nuts from

Guinea Bissau. This is probably not specific to Guinea Bissau, but reflects the general fact that the smaller the nut, the higher the percentage out-turns.

❖ Côte d'Ivoire

The germplasm collection of CNRA (Centre National de Recherche Agronomique) at Lataha consisted of 36 trees, planted in one row in 1984, with a spacing of four meters between them. The history is that the seed for these trees originated from one tree in Brazil and certainly the visual characteristics (size of nut and tree) would suggest that the trees did originate from either one or more "Brazilian common" trees. These trees are very large, and with only four meters of spacing between them, yield data cannot be very accurate, particularly as a potential indicator for further planting. With wider spacing and a full canopy, many of the trees would yield much more.

Seed from some of the original germplasm collection was planted in 1997 in a new block of 45 trees, at a spacing of 8m x 6m.

No new cashew material has been introduced into Cote d'Ivoire recently. Some time ago, however, seed from Brazil, presumably from large common trees, was imported and planted on an estate at Badikaha (near Korhogo). The SODIRO cashew plantation (100 ha) that was planted in 1993, used seed from this farm in Badikaha. Both sites would be good areas to evaluate the yield of a few visually good trees, for possible selection and trials.

Since 1995, ANADER (Agence Nationale d'Appui au Développement Rural) has been selecting seed from visually good trees, on the basis of colour of apple, yield, tree structure and size of nut.

The issue of planting material was very confused in people's minds, and nothing is being evaluated on farm and very little on station.

A very informative visit was made to the farm of Mr Kone Koulouba, in Koro Ouleu village. The farmer started to plant an additional 4 ha of cashew in 1992, with assistance from ANADER. The seed for this block was **all** taken from one supposedly superior "selected mother tree" and, as is often the case, this selected tree was growing under ideal environmental conditions, namely:

- isolated from other trees, hence canopy well developed to give good yield
- open aspect
- good access to sunlight
- good access to soil nutrients and water
- little competition.

Whether this tree is in fact superior due to its ideal environmental position, or whether there is any genetic basis for its above-average yield, can only be determined in a properly designed trial comparing it with other good material. This is unfortunately a typical example of "mother tree" selection found in many countries. (NB "Selected mother tree" often means a local tree with supposedly superior qualities such as yield or nut weight.)

All germplasm material planted so far has been from seed; no vegetatively produced seedlings have been used. Developing the technique of vegetative propagation was given high priority at a internal stakeholder meeting held previously.

❖ Ghana

The germplasm collection of UDS/SARI (University of Development Studies/Savannah Agriculture Research Institute) at Tamale consisted of trees grown from seed, taken from sixty local “selected mother trees”. Eight seeds from each of the 60 mother trees were planted in 1997, in **one** replicate.

The material used for planting the Pokuase germplasm collection, near Accra, was seed from local trees. The performance of the mother trees was not evaluated; seeds were simply collected from trees around the vicinity. About 50% of the seedlings were dead. Such a trial has very little value.

Technoserve Ghana has imported seed from the CP range of Brazilian clones and “jumbo” nuts from Nigeria. Over 20 tons of “jumbo” nuts have been imported since 1995 and more were being imported in 2001; this material is being sold to farmers. There appears to be no evaluation of these introductions by research or NGOs.

At the MIM estate in Ghana, some of the trees were grown from seed from India, and the rest of the seed were obtained from an old local plantation, at Sampa. Now they are selecting mother trees from their own plantation based on yield and nut size. It was useful to note that trees originating from seed from India were more susceptible to damage by thrips.

Technoserve Ghana initiated the selection of mother trees in 1994, but found that trees produced from the seed were very variable. Seed provided to farmers working with ADRA was obtained from selected mother trees in Wenchi district, and subsequently from MOFA (Ministry of Food and Agriculture), again from selected local mother trees. All of this new planting will be very variable and much of it without any particularly desirable qualities.

As already mentioned before, there are some evaluation of local “mother tree” selections, but little else. No vegetative propagation of cashew is being undertaken. It is only recently that the issue of cashew research has been given any priority by the Government.

❖ Nigeria

The CRIN (Cocoa Research Institute of Nigeria) sub-station at Ochaja was ‘home’ to a number of breeding trials, namely:

- ‘Block NW-7’ was the original germplasm collection planted in 1977, with half-sib accessions from Brazil, India, Tanzania, other countries and locally selected material. There were 32 plots of four trees (i.e. four seeds from one tree) replicated twice. Eighteen types have been selected for farmer planting.
- Brazilian “jumbo nut” trial – these nuts were obtained from Kosoni Farm (Oro, Kwara State). They were graded according to weight and then the entire block of seven ha was planted according to nut weight, that is, the smallest nuts at one end, rising to the biggest nuts at the other. Spacing was 9 x 9 m. The nuts were not from selected trees.
- Millennium block – Brazilian jumbo type nuts were being evaluated at different spacing, 9 x 9m, 8 x 8m and 6 x 6m. Again each plot was planted according to nut weight, with the lower weight nuts at one end moving to the highest weights at the other end.
- Other trials were also made, and some of the older ones had been earmarked for upgrading trials.

At another site, half-siblings of twenty five locally selected “mother trees” were being evaluated, with four seeds from one tree being planted per plot and replicated twice.

There does not appear to have been much new planting material introduced in very recent years. However, in the past, there has been quite a lot, e.g. ‘Block NW-7’ and others at Ochaja sub-station and Brazilian “common” or “jumbo” seed imported and planted at Kosoni-Ola Farm (Oro, Kwara State). On Kosoni-Ola Farm, an area of 350 ha was planted entirely with Brazilian “common” seed imported from Brazil. Planting started in 1986 and was finished by 1988 and then gapping (filling in of spaces) continued. Nut size was variable, but a high percentage of trees were giving a very good nut size. It is from this farm that Ghana imports the Nigerian “jumbo” nuts. Yields were low, last year 250 ha produced only 50 tons, equal to only 200kg/ha. However this type of tree needs to be evaluated fully, e.g. for yield potential per ha, kernel weight, percentage kernel out-turn, etc. before recommending it to the farmer.

Improved seed sold by CRIN comes from selected individual trees, but because of out-crossing, it is likely to be very variable. A polyclonal seed garden would improve seed production. Here clones of a number of the best trees (perhaps 20) are grown together in a certain arrangement and allowed to cross pollinate. The resulting seed would be a mixture of the characters of the selected clones and resulting trees should be better than the existing farmers’ trees

Only air-layering (marcotts) had been practised on a limited scale; this technique is rarely used these days, because it is time consuming and has a low success rate; tip or bud grafting are normally used in East Africa, India and Brazil.

Nigeria has a long history of cashew breeding research, as demonstrated by replicated germplasm trials planted in 1977 and a number of papers published in regional journals.

Conclusions on breeding

There is a tremendous amount of enthusiasm for cashew cultivation amongst both farmers and the authorities in all the five countries, and the farmers are expanding their cashew, often with little or no support. Only Nigeria has seed for sale that has been evaluated to a certain degree and even there, the CRIN seed could be substantially improved.

The universal complaint in all the five countries was the lack of good planting material. Much needs to be done with regard to selection, introducing new material, establishing germplasm trials for the short, medium and long term, breeding and finally distribution of planting material to farmers. Because of the long time frame for evaluating cashew material, the need to multiply good material for distribution and the importance of providing farmers with the right material, funding for a future regional breeding programme should be given the highest priority.

A related area that needs immediate attention is the introduction of tip or bud grafting techniques to produce clones (genetic replicas of the original mother tree). Without this technique, the breeder’s trials are severely constrained, since they have to use half-sibling seeds all the time, which introduces more variability into the trials. With cashew being such a variable crop anyway, this is undesirable.

Research capacity

With the exception of Nigeria, generally speaking very little research has been undertaken on any cashew related topics in the five countries. This lack of research is not really surprising, as it

reflects the relative ‘newness’ of cashew in the region (other than for forestry purposes) and that in some countries, government research organizations have only recently been either mandated or funded to work on cashew. Funding is a critical limiting factor in all countries, with budgets extremely tight or non-existent.

In all countries, but to a lesser extent in Nigeria, cashew research is seriously constrained by at least one or more of the following:-

- Limited manpower, especially considering that cashew is grown over a wide area and that there is much research work to do.
- Limited in-depth experience of cashew
- Lack of funds for trials, travel, labour, equipment, etc.

It must be understood that since cashew is a tree crop, research work on it is a long-term undertaking, with no instant solutions and answers. It therefore requires long-term commitment, in terms of both funding and of personnel.

2.4 Land and climatic constraints

A qualitative assessment indicated that large areas of land suitable for cashew was still available in all the countries visited, and so land would not be a limiting factor for a long time. This was based purely upon a visual assessment of the environment, a rudimentary look at the climatic data, but most of all upon the fact that existing plots of cashew were growing well throughout the survey area. Cashew can have an important role in providing a sustainable increase in smallholder income in an environmentally friendly way.

Total rainfall and the number of months with good rains decline progressively in a northward direction. The two surveys were carried out in the main cashew areas of each country and, generally speaking, this was in areas receiving not less than 1,000mm of rain per year. It would be useful to do another survey further north, in areas receiving less than 1,000mm of rain, where environmental problems are greater, crop opportunities for farmers more restricted, with less alternative sources of income and poverty more widespread.

In Ghana, the problem of migration of people from the north to the south was being debated in Parliament at the time of the survey. Cashew could provide an important source of income along with environmental benefits in these more challenging regions.

2.5 Extension and farmers’ organisation needs

The factors constraining production are derived from observations made during the undertaking of the two surveys. Once knowledge or a particular technology has been developed either by research and/or by farmer groups, it is further tested in on-farm trials. If proved successful, the results should be transferred to the largest possible number of future beneficiaries. Without a good level of farmer adoption, the knowledge or technology is wasted. In all of the countries surveyed, the extension service for cashew farmers in most parts was:

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- Weak - extension personnel were present, but were not fully trained, with major gaps in their knowledge, for example regarding identification and treatment of pests and diseases, or
 - Limited in manpower, transport and/or financial resources, or simply non-existent.
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Extension is a very important, but also a very difficult and complex issue, especially when dealing with numerous and widely spread resource poor farmers. Many millions of dollars have been spent by countries taking loans from the World Bank to develop the Training and Visit system of extension, which is now thought by many to be inappropriate for resource poor farmers, living and working in environments which are characterised by their complexity, diversity and risk proneness.

The Training and Visit system is characterised by the following facts:

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- It is often expensive, and hence unsustainable in developing countries
 - It deals with “contact” farmers and the information is supposed to trickle down to the vast majority of non-contact farmers, which of course it rarely does
 - It uses regimented “do this” and “do that” impact points, which are often not suitable for the agro-ecological and socio-economic circumstances of the individual farmer.
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To help to overcome these overwhelming problems, alternative approaches need to be tried, for example:

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- A knowledge-based approach to extension, that has many benefits over simple impact points. It builds upon the existing knowledge of the farmer, to give him/her a better understanding of the problem, so that existing and future technologies can be adapted to suit his/her own agro-ecological and socio-economic circumstances.
 - Building and strengthening farmer associations to act as focal points for extension activities
 - Training farmers themselves as extension workers. These farmers would still require regular supervision, to ensure that they are not making mistakes and passing this on to others.

Farmer associations

Farmer associations in one form or another were met in all countries visited, and most were receiving no support at all. It is important that these associations become successful and provide tangible benefits to their members, especially the poorer ones. Not only do farmer associations potentially benefit the farmer financially, by negotiating higher prices for outputs and lower prices for inputs, they are also very effective vehicles for knowledge and technology transfer and rural development in general. There is an urgent requirement for specialised input regarding farmer associations. It appeared to the survey team that the bigger the association became, the less tangible were the benefits for the smaller farmer.

Training was a constant request from nearly all farmer associations, including the larger ones, found, for example, in Côte d'Ivoire. It is vital that training is provided as soon as possible, especially for the smaller, new farmer associations (e.g. those found in Guinea and Ghana), before problems are encountered and enthusiasm wanes. Training needs to be given in accounting, management, transparency, communication, etc. Obviously, specialised input could decide the most appropriate course of action, but a well-trained cadre of farmer association specialists in each country is a minimum prerequisite. These people in turn could train and support the developing associations.

Right balance between food security and diversification of cash crops

Achieving an appropriate level of diversification of risk for farmers is important for long-term stability. In Guinea Bissau rice production was declining, due, partly at least to increased cashew planting. As a result rice imports had increased. In semi-arid areas cashew can have a competitive advantage over some other food crops. Thus, putting a higher proportion of farmer resources into increasing cashew production at the expense of food security is acceptable, providing cashew prices remain attractive and the income generated is more than enough to buy food for the family. Serious problems can arise, however, if cashew prices become unattractive, or yields decline drastically. It is therefore important to get the right balance between food security and diversity of cash crops. This is especially so for tree crops, which have a much longer time frame to maturity than annual crops.

An example of over-reliance on a single cash crop was that of mangoes in the Kankan region of Guinea. Mangoes were the most important cash crop until the mango-processing factory in Kankan closed in the 1980's, reducing the local demand. However due to the long-term nature of tree crops, production kept increasing. To make matters worse, all trees produced at the same time, as there were no later-harvesting varieties. Hence it was very difficult to sell the mangoes, or to get a good price at the time of plenty. This is one of the reasons why many farmers are starting to plant cashew in this region, where previously there was none.

Cashew can have many both financial and environmental advantages in semi-arid regions, but it is important to take a holistic view of crop development in these fragile, risk prone environments. Consequently other crops, both food and cash crops, need to be taken into account.

3. Marketing constraints

Only in the remoter parts of Guinea and in those areas where cashew was very new, have there been problems of actually selling the crop in the last year or so. For example:

- Mr Mamadou Diakhaby (Sintouridjaga, Gaoual Prefecture, Guinea) sold his yield in Guinea Bissau by taking it there himself on passing trucks! His was one of the very few cashew farms seen between Gaoual and Dabola and there was no association in this area due to the very limited number of cashew farmers.
- At the meeting with the Koumbia Association of Cashew Growers (Guinea), lack of buyers was given as one of the constraints and one member took his yield to Senegal but could not find a buyer (this was in marked contrast to another farmer who said he sold his cashew crop in Senegal for the very high price of CFA 1250/kg).
- In 1999 Mr. Sumani Alhassan, (Libga village, Savelugu/Namton district, Ghana) could not find a buyer in his area and hence his yield was wasted; by contrast in 2000, there

were three buyers each offering successively higher prices. Obviously the situation is improving there.

In Sansale region (Guinea), farmers often exchanged cashew for rice; in 1999, one bag of rice was equivalent to 1.5 bags of cashew, while in year 2000 it had increased to two bags of rice = one bag of cashew. In Guinea Bissau bartering for rice was a very common practice.

The majority of farmers did not have a problem selling their harvest. In the more remote or new areas, the situation is improving and will continue to improve, as more farmers plant cashew. If the lack of buyers is a problem, then farmers need to co-operate by bulking their nuts and arranging transport themselves, where possible.

Prices

From interviews with large numbers of farmers, it would appear that generally, the maximum prices paid to farmers were in-line with what could be expected from international prices. However the following problems were apparent:

- Prices were variable during the season, with disproportionately low prices at the beginning of the season. Farmers who were short of cash early in the season were forced to sell, often at very low prices
- Prices were variable between neighbouring villages at the same time of year, because buyers were exploiting the lack of price knowledge of farmers
- Farmers were lacking information on local and international prices
- There was no price premium for nuts of better quality or size. This does not encourage farmers to improve the quality of their cashew, which will become an increasingly important factor in the future
- Farmers in remote areas received lower prices, due to higher transportation costs.

4. Processing status and constraints

The majority of raw nuts harvested in all the five African cashew-producing countries are shipped to India for processing and then re-exported to USA, Europe, Japan, etc. Although this route is perfectly acceptable, as farmers can still derive a good income from growing cashew, any potential value-added from processing is lost to the country.

Major benefits are to be gained when the processing of the nut and the apple can be undertaken locally, rather than exporting the raw commodity. However, care must be taken to ensure that the farmers do not end up subsidising inefficient and unprofitable processing industries. This can happen if high taxes are imposed on the export of raw nuts, in order to allow local processing industries to compete with India.

Further are given several examples of various processing industries in the countries visited.

❖ **Guinea**

No processing of kernels takes place.

❖ **Guinea Bissau**

There was one large cashew-processing factory of Italian origin (probably manufactured by Oltremare), which has never functioned. The reasons for the demise and what must have been a

substantial loss of investment were not determined. There was a small amount of hand processing for the local market and for export to Portugal, and the objective was to process more. There have been a number of projects to develop hand processing, but it was difficult to get information on exactly how much was being processed by hand.

❖ Cote d'Ivoire

The SODIRO cashew (and rice milling) factory at Odienne started processing in May 1998. All the machinery was bought from India and one Indian technician spent a year at SODIRO training people. The finished kernels were vacuum packed in nitrogen for export, and smaller packs of ready to eat cashew were also produced for the local market (demand apparently was not high). The factory was well organised and maintained, and the environment for workers was very good. The finished kernels looked of a high quality and the taste was good.

In early 2000, SODIRO bought 1,400 tons of raw cashew nuts and by January 2001, they had only processed 700 tons, in spite of the fact that the new buying season was about to start. The factory had a capacity of 2,500 to 3,000 tons per year. In 2001 the factory was running at less than one third of capacity and most of the machines were idle. The reason for this was that they had not managed to sell a substantial proportion of their processed kernels since starting in 1998 (approx. 4,000 cartons of 22.68kg each remain unsold in Abidjan). The factory employs 800 people, of which 700 are women. Supply of labour is not a problem. This potentially very serious marketing problem urgently needs to be examined in more detail.

The CAJOUICIS cashew-processing factory at Korhogo was using both mechanical and hand processing equipment to produce kernels. The mechanical equipment was purchased from Oltremare in Italy and installed in 1979. The factory has a capacity of approximately 2000 tons of raw nuts per year. Some of the kernels were organic; apparently some fields have been certified as organic and the produce from these fields was kept separate from the rest.

In addition to the mechanised factory, they started with manual processing using Indian machines in 2000. In 2001 they were processing 1.5 tonnes per day with this method and hoped to increase to 2 tonnes per day. Two shifts operated. Kernel out-turn was given at between 21 and 22%.

❖ Ghana

Technoserve has been instrumental in setting up a fledgling cashew processing industry. The company organised in 1996 a processing workshop for farmer groups. In 1997, a business plan was drawn up for a processing plant with a capacity of 30 tonnes of raw nuts/year and the equipment was installed the same year. The association that owned the small factory paid 20% of the cost up front and Technoserve loaned the rest of the costs for that year. Loans for subsequent years were organised through the normal banking system, guaranteed by Technoserve. In the first year of operation 2 tonnes of raw nuts were processed. Members of the association bought shares in the company. Processing was by hand, using both the Indian and Brazilian hand shellers, although the Brazilian one is preferred. All of the machines were made in Ghana. This processing system has been replicated twice more, so there are now three processing factories in all, based at Msawkaw; Kabile; and Sampa.

The target for the three units in 2001 was to process 12 tonnes of kernels (approx. 48 tonnes of raw nuts). These kernels go to the "Golden Harvest" company for final roasting, salting and packaging for the local market. The kernels are packaged in 100g bags or 250g jars. The Golden

Harvest Company is owned by the three processing associations (45%) and Ms. Esi, who owns Mase Foods. Technoserve was instrumental in setting up this arrangement.

Ghana is a new and small producer of cashew (5,000 tons per year and increasing), but they were already thinking about the benefits of the value-added from processing. This was an important move to initiate a processing industry very early in the cashew development phase.

❖ Nigeria

Premier Cashew Industry Estate (Oghe, Enugu State) had an old cashew-processing factory that stopped operating in 1979. In 1989, a new Japanese factory was commissioned, with an operating capacity probably of more than 2,000 tonnes per annum. This modern factory was totally vandalised in 1998 and is now beyond repair, although the buildings could still be put to good use after restoring the roof. It was said that the employees had not been paid for some time and, in their frustration, destroyed the factory. The factory must have cost a few million US\$ and was destroyed after only nine years of operation.

The Cashew Processing Industries factory (Ibadan, Oyo State) was commissioned in 1990 and was purchased from Oltremare of Italy. The oil bath mechanism had to be by-passed due to scorching or browning of kernels. Why this should happen was unclear, since the Oltremare technology for roasting nuts works well in other factories around the world. Steam roasting was introduced and the machinery for that was fabricated in Nigeria. Now nearly all of the original Oltremare machinery is obsolete, with only the ovens and packing machine operational (packed into tins with CO₂). The company had introduced Indian type hand shelling machines in 1999 (made in Nigeria), and either one or two people operate one machine. Apparently two people can shell up to 60 kg of raw nuts in an eight-hour shift.

The kernel out-turn ratio after shelling was said to be 28%, and by the end of processing it was 22%. There were some ongoing marketing problems. The company needs credit to purchase raw nuts, to pay for labour, buy consumables, etc. However, the bank will not loan any money until the prospective purchaser of kernels has issued a letter of credit - and they are finding it difficult to find buyers, especially from overseas. Why this should be so was not made clear. They now hope to sell raw nuts from the cashew estate that they own (Processing Industry Farm at Iwo, Osun State), in order to finance processing of other people's nuts under contract. It remains to be seen whether this will work or not.

Conclusions on processing of nuts

With regard to the processing of nuts, the story is mixed. On the positive side is the initiative in Ghana and the CAJOUICIS factory at Korhogo, Cote d'Ivoire. In the intermediate position is the SODIRO cashew factory at Odienne, Côte d'Ivoire, with a good operation but marketing problems. On the negative side were the destroyed Premier Cashew Industry Estate factory (Oghe, Enugu State); the Cashew Processing Industries factory (Ibadan, Oyo State) with changes needed in the processing stage and obsolete machinery, followed by marketing and financing difficulties. Both of these examples are in Nigeria. There is also the abandoned factory in Guinea Bissau.

It is very important that a regional review of marketing of processed kernels is undertaken, as obviously a number of factories are experiencing problems in this area.

Use of cashew apples

In all countries visited, the vast majority of cashew apples, which are nutritious and high in vitamin C, are simply wasted.

In Lafia state (Nigeria), there was more interest in using the apples: apples were sold in the market and by the roadside. There was also interest expressed in processing the apples into juice.

The most remarkable use of apples seen during the survey was the production of very good cashew-apple brandy at the MIM Agro and Industrial Projects Estate in Ghana. The unique aspect of this plantation was that they make a very professional cashew-apple brandy. The brandy was an after-thought to the plantation, but to date they have produced 42,000 litres (60,000 bottles of 0.7 litres) mainly for the local market. They are now trying to access the European market.

5. Research and Development recommendations

The following table provides a summary of research and development recommendations arising from the surveys. Priority is on a scale of 1 to 3, and estimated cost on a scale of low – medium – high.

Summary of research and development recommendations

Priority	Objective	Relative cost
1	Implement vegetative propagation workshop	Medium
1	Implement selection and breeding trials	High
1	Produce standardised manual of pests, diseases, research methods in English and French	Medium
1	Clarify the importance of anthracnose	Low
1	Construct database of yield records	Low
2	Review literature of fire prevention and evaluate strategies	Medium
2	Collect quantitative data on the economic status of pests and diseases	Medium
2	Develop appropriate control strategies for pests and diseases.	Medium
2	Determine factors responsible for drying of flowers	Low
2	Evaluation and enhancement of natural control of insect pests	Medium
3	Review economics of high density planting	Low

Other recommendations include:

- Review support for extension and implement participatory, knowledge based pilot extension project
- Implement programme on training and support for farmer associations
- Review marketing of kernels
- Develop uses of cashew apples

References

- Boma, F., Topper, C. P. and Stathers, T. (1998) Population dynamics of *Helopeltis spp.* On cashew in Southern Tanzania. Int. Cashew and Coconut Conference, Tanzania, 17-21 February, 1997.
- Camara and Vayssie (1996). La filiere Anacardier en Guinea Bissau. Ministere du developpement Rural et de l'agriculture (MDRA). Novembre 1996.
- Camara and Vayssie (1997). La culture de l'anacardier en Guinea Bissau, superficie production, qualite des noix campagne agricole 1996/97. Ministere du developpement Rural des Ressources Naturelles et de l'Environnement (MDRRNA). Decembre 1997
- Hill, D. and Waller, J. (1988) Pests and diseases of tropical crops, Volume 2, A field handbook. Longman Scientific and Technical.
- Lefebvre, A., et al (1973) Etudes sur l'anacardier . II Techniques de creation et d'entretien des plantations fruitieres d'anacardier. Fruits (France), 28, 4, p271-278.
- Sardinha *et al* (1993) Selection of superior genotypes of cashew (*Anacardium occidentale* L.) in Guinea Bissau and the development of *in vitro* techniques for their propagation. (European Union Contract no. TS2-A-0167 P).
- Topper, Clive P.; Caligari, Peter D. S.; Camara, Mahmoud; Diaora, Souret; Djaha, Akadie; Coulibaly, Felix; Asante A. K.; Boamah, Adomako; Ayodele, E. Akin; Adebola Patrick O. (2001). West Africa Regional Cashew Survey (covering the countries Guinea, Guinea Bissau, Cote d'Ivoire, Ghana and Nigeria). Volume 1. Report number BHA 01109. BioHybrids Agrisystems Ltd., P.O. Box 2411, Earley, Reading RG6 5FY, UK. Produced for the Sustainable Tree Crops Programme, funded by STCP/USAID.
- Topper, Clive P. and Caligari, Peter D. S. (2001). West Africa Regional Cashew Survey (covering the countries Guinea, Guinea Bissau, Cote d'Ivoire, Ghana and Nigeria). Volume 2. Report number BHA 01110. BioHybrids Agrisystems Ltd., P.O. Box 2411, Earley, Reading RG6 5FY, UK. Produced for the Sustainable Tree Crops Programme, funded by STCP/USAID.
- Topper, Clive P. and Caligari, Peter D. S. (1999) Assessment of Options and Opportunities for Tree Crop Development in East and West/Central Africa. Report number BHI-99104. BioHybrids Agrisystems Ltd., P.O. Box 2411, Earley, Reading RG6 5FY, UK. Produced for the Sustainable Tree Crops Programme, funded by STCP/USAID.
- Topper, C. P., Pearce, M., Grunshaw, J. and Anthony, J. (1997) Preliminary observations on the role of common intercrops in the population dynamics of *Helopeltis* and damage to cashew. Int. Cashew and Coconut Conference, Tanzania, 17-21 February, 1997.