5. Insect pests

5.1 Introduction

Many trees were observed at the time of panicle production, flowering and nut set in different regions in each country. This time period is the most critical with regard to production of nuts and apples; it is also the time when pests and diseases are at their most damaging. Naturally there may be other pests and diseases that occur at other times of the year, but their effect would be mainly on vegetative production. Fortunately cashew trees can withstand substantial damage to leaves before there is a reduction in yield. It is also highly likely that pest populations will vary in intensity from year to year and place to place.

Damage from the different insect species, albeit at different levels of seriousness, was generally widespread throughout all the survey countries. Therefore insect pests have been discussed on a regional basis rather than country by country. Even though perhaps a particular insect pest species is not a problem in one country at the moment, many insect pests have the 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.

Where visually obvious symptoms of pest or disease damage were present at a particular site, this has been noted in Annex 1 or 2.

Details of the main insect pests observed during the survey follow and they are grouped according to the type of damage inflicted on cashew.

5.2 Sucking pests

5.2.1 *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 and it was difficult to distinguish the relative importance of *Helopeltis*. In Nigeria *Helopeltis* was present but damage levels were very low.

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 around the point of entry of the labial stylet into the plant tissue. The tissue around the stylet puncture dies, presumably in response to the enzymatic action of the insect's salivary secretions. 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 (see Section 6.2 below).

When *Helopeltis* feeding pressure is sufficiently intense the whole shoot dies and this damage is typically called 'Dieback'. Dieback is characterised by the following symptoms - withering of the inflorescence or shoot, followed by progressive dieback, generally starting from the tips and later advancing downwards to the main floral shoots and leaves. The normal green colour of healthy shoots progressively turns brown/black followed by drying up and necrosis, and as a result, fruit or new shoot formation, is arrested (see Photos. 1 and 2, Volume 2). In very serious cases, the entire tree looks burnt.

Helopeltis damage can be difficult to distinguish from early instar *Anoplocnemis curvipes* damage (see Section 5.2.2).

Helopeltis was responsible for significant loss of yield at a number of sites, most notably at the farm of the President of Guinea (see page 4, Annex 1) and at the farm of Mr. Diallo near Koumbia town, Guinea (see page 12, Annex 1).

At the President's farm the level of damage observed was significantly reducing yields and apparently all of the 75 ha of cashew was very badly damaged. The extension officer responsible had little knowledge about pests and diseases.

At the farm of Mr. Diallo (near Koumbia town, Guinea) sucking pest damage was negatively affecting the yield, although some trees seem to have escaped serious damage. Table 9 provides an estimate of the effect this level of insect damage was having on farmer income. The model starts with Mr Diallos' actual yield for the whole farm in 1998 (2000kg) and assumes that in 1998 insect damage was minimal. Next it is assumed that as the trees are around the age of 5 years old and growing well, yields would have increased by 20% a year to 2400kg and 2880kg in 1999 and 2000 respectively. The actual yields were much less than expected and it is estimated that the yield loss was just under 40% in both 1999 and 2000. The results from Table 9 suggest that insect damage was causing substantial economic loss to Mr. Diallo; this loss is likely to be of a similar magnitude in 2001.

Table 9. Predicted loss of revenue due to insect damage, Koumbia, Guinea.
(NB Copied from Annex 1, Table A1.4)

Year	Expected yield, Kg	Actual yield, Kg	Percentage loss of expected yield	Loss in revenue, $
1998	2000	2000	0	0
1999	2400	1500	37.5	450
2000	2880	1800	37.5	540

Assumptions regarding Table 9 above:-
1. In 1998 there was no loss of yield due to insect damage, although it is likely that there would have been some.
2. Yield would increase by 20% per year for 1999 and 2000.
3. Price per kg of raw nuts was $0.50

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*. 1997 and Topper *et al*, 1997). In India, *Helopeltis antonii* (the tea mosquito) is the main production constraint. It is therefore 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.

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

Damage symptoms:-
A. curvipes is in the same sub-order of insects as *Helopeltis* and it feeds in a similar way by penetrating the living tissues of plants with their piercing mouthparts and imbibing the sap. Photos. 4, 5 and 6 (Vol.2) show examples of *A. curvipes* damage and Photo. 3 (Vol.2) shows an adult of the species in the field.

A. curvipes is distributed throughout Africa where they suck the sap of a variety of plants. Hill and Waller (1988) in their "Field handbook of Pests and Diseases of Tropical Crops, record that both sesame and coffee can be seriously attacked by *A. curvipes*. This pest can also produce an unpleasant odour.

A. curvipes damage was widespread in West Africa and was particularly serious in Cote d'Ivoire and Ghana. Annex 1, pages 21 to 24, gives descriptions of visits to various farms and how *A. curvipes* frequently featured in the list of main constraints for Cote d'Ivoire.

Below are a few extracts from Annex 2, showing the seriousness of *A. curvipes,* for some farmers in Ghana.

Visit to cashew field 1 km from the village of Mesidan

> "This cashew farm was severely damaged by *Anoplocnemis curvipes*, with a high percentage of dead shoots, which were seriously affecting the yield".

Visit to 1st field of Mr Boachie Ameyaw (member of Koase Cashew Farmers Association).

> "Damage due to *Anoplocnemis curvipes* was severe and was significantly affecting yield and tree growth (Photo. 6, Vol.2). According to farmers the insect was most active early in the morning".

Visit to 2nd field of Mr Boachie Ameyaw.

> "The trees here were 4 years old and bee keeping was practised in the field. All trees were damaged by *Anoplocnemis curvipes*, but on some trees, nearly every shoot had been killed and was now shooting again. Three of these damaging insects were seen, 2 were mating (late afternoon)".

In the district of Koase (near Techiman, Ghana) the farmers wanted to spray in order to protect their cashew trees, but ADRA (an NGO working with farmers) was unable to supply the insecticide because of USAID's (ADRA's funding agency) stringent regulations regarding pesticide use.

Because of the seriousness of sucking pest damage, Technoserve (another NGO working in Ghana) started to evaluate 5 insecticides for the control of sucking insect pests at 5 locations in 1995. The work should have continued for 2 more years but funds ran out and government research had no mandate to work on cashew at the time. According to both NGOs, pest attack takes a heavy toll on cashew.

5.2.3 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. Adult thrips are very small, (see Photo. 7, Vol.2).

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 species can transmit viral diseases. As a result of such feeding, mainly on more mature cashew leaves, the leaves turn a bronze colour and eventually drop off (Photos. 7 and 8, Vol.2).

Thrips were widespread throughout the 5 countries surveyed, and usually damage was minor and of no economic significance. However in two places in particular, thrips were responsible for serious levels of defoliation and yield loss. The first was the farm of Mr. El

Hadj Makanera Abdoulaye of Boke, Guinea (see page 5, Annex 1) and the second was the MIM Estate in Ghana (see page 4, Annex 2).

At the farm of Mr. El Hadj Makanera Abdoulaye in Boke, the main production constraints were a combination of thrips and *Helopeltis*, with both types of damage widely distributed over the entire farm, and one large area in particular being totally defoliated due to thrips (see Photo. 8, Vol.2). Extension agents incorrectly thought that anthracnose was responsible for this damage.

Table 10 provides an estimate of the effect this level of insect damage was having on farmer income. The model starts with the actual yield for the whole farm in 1998 (5,000kg) and assumes that in that year insect damage was minimal. Next it is assumed that as the trees have ages ranging from 2 to 10 years old and are growing well, yields would have increased by 20% a year to 6,000kg and 7,200kg in 1999 and 2000 respectively. The actual yields were much less than expected and it is estimated that the yield loss was 58% in 1999 and 65% in 2000. As can be seen from Table 10, insect damage was causing substantial economic loss to Mr. Makanera Abdoulaye and this would probably be of a similar magnitude in 2001.

Table 10. Estimated loss of revenue due to insect damage, Boke, Guinea.
(NB. Copied from Annex 1, Table A1.2)

Year	Expected yield, Kg	Actual yield, Kg	Percentage loss of expected yield	Loss in revenue, $
1998	5,000	5,000	0	0
1999	6,000	2,500	58	1,750
2000	7,200	2,500	65	2,350

Assumptions re Table 10 above:-
1. In 1998 there was no loss of yield due to insect damage, although it is likely that there would have been some.
2. Yield would have increased by 20% per year for 1999 and 2000.
3. Price per kg was $0.50

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, as without this, the trees would be completely defoliated. Tractor drawn sprayers were used, since back-pack 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, which was a useful observation.

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.

5.3 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.

5.3.1 *Apate terebrans* (Coleoptera, family Bostrychidae)

The most spectacular example of borer damage was found on the farm of Mr Nanga Yeo in Seguela district, Cote d'Ivoire). Here in one 6 year old tree, **37** adult borers were found causing extreme damage and the death of the tree (Photos. 10 A and B and 11, Vol.2). The

tree was surrounded by light brown sawdust just like that obtained when sawing wood, which is in contrast to other borers where frass and sawdust are mixed giving a dark brown colour. It is possible that this is simply the difference between adult and larval feeding. Specimens were sent for species confirmation to the British Natural History Museum and were identified as *Apate terebrans* Pallas (Coleoptera, family Bostrychidae). The following information was provided by the Natural History Museum:-

> '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 polyphagus and Hill and Waller (1988) in their "Field handbook of Pests and Diseases of Tropical Crops", record *A. terebrans* as attacking coffee, citrus, cocoa, guava, cotton and other plants.

Cultural control is usually recommended whereby a flexible wire (eg 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, can be kept under control quite easily.

The most bizarre example of "borer damage" was where a member of the team had casually identified borer damage, which in fact turned out to be buck-shot from a shot gun!

5.3.2 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. In Nigeria, *Analeptes*, the cashew girdler, was reported as a serious problem by a group of farmers met at the CRIN Ochata sub-station; it was seen to be a problem at the Premier Cashew Industry Farm at Orji River, Enugu State and at the Cashew Processing Industry Farm at Iwo, Osun State.

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 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 colouration; it can reach a length of about 55mm and its antennae a further 70mm. The adult is generally black but on the wing cases there are 3 bright orange coloured bands.

5.4 Other insect pests seen or mentioned by farmers that were of <u>minor</u> importance 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 cause serious economic damage in some areas.

5.4.1 Aphids (Hemiptera; Aphididae).

Aphids were present at a few sites but 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 and disappear as soon as the heavy rains start.

Aphids can be controlled naturally by a number of other insect predators and parasites.

5.4.2 Lepidoptera

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

5.4.3 Termites

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

5.4.4 Mealybugs (Hemiptera, family Pseudococcidae)

Mealybug was seen only on 2 occassions, it was present on many panicles at the farm of Mr Abou Alhadji Uba, 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 it is very difficult to control.

5.4.5 From the literature

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

Emoroetis spp (Lepidoptera,Family Lymantriidae, Liparidae) was listed as a pest of cashew by the Plant Protection department in Guinea Bissau.

5.5 Non-insect pests

In Guinea and Guinea Bissau, squirrels were reported to be a pest as they cut the stems of young cashew plants (e.g. pages 7 and 8, Annex 1).

Birds or bats eating the apples (e.g. page 7, Annex 1) and birds taking germinating seeds (e.g. page 14, Annex 1)

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

Oligonychus coffeae (Tetranychidae) was listed as a pest of cashew by the Plant Protection department in Guinea Bissau. These mites are very small indeed and leave behind a white powder meshed with fine silken threads. It feeds on many plant species, including *Acacia sp, Anacardium, Citrus sp, Coffea, Gossypium, Mangifera*, etc. Its geographical distribution is widespread. Whether this species causes any economic damage remains to be seen.

5.6 Conclusions

Conclusions for pest problems will be discussed in Section 6.6, together with those for diseases, to give a better perspective on what are the most important biological constraints for cashew production.

6. Disease constraints

6.1 Introduction

As has been noted previously, the surveys were undertaken at the most critical time of year as regards production of cashew, i.e. at the time of flowering and nut set. 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.

If visually obvious symptoms of disease damage were present at a particular site, this is noted in Annexes 1 and 2. Diseases observed during the survey were as follows.

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, Photo. 15 (Vol.2) shows definite anthracnosis on leaves and nuts of cashew in Brazil. 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 this one-off survey of West Africa, only **very minor** amounts of what looked like **"fully developed"** anthracnose were found (to be completely sure samples would have to have been sent for confirmation of the causal pathogen). Fully developed anthracnose was possibly present at the following sites:

- on a small number of leaves on a plot just outside the capital Bissau (Photo. 12, Vol.2) (Guinea Bissau).
- on a very small number of apples and nuts from Brazilian material, Foulaya, Guinea (Photo. 13, Vol.2)
- on leaves from Brazilian Common trees, CRNA, Lataha, Cote d'Ivoire (Photo. 14, Vol.2)

The survey was planned to take place during the most critical period affecting yield, namely at flowering and nut set. During this period, only tiny amounts of what might have been fully developed anthracnose were seen, on a very small number of trees from the many hundreds of trees that were inspected. In the 2001 production year and in those areas visited in the 5 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, we can conclude that anthracnose had no or only a minor affect on yields in 2001 in the main cashew producing areas visited. The drier areas further north, which were not visited, would be even less likely to have anthracnose.

This 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. For example, the following pieces of information provided during the survey would suggest that anthracnose is a reasonably serious disease of cashew:-

- Guinea Bissau Plant Protection department personnel informed the survey team that anthracnose was found 6 years ago and was becoming increasingly important. Cashew material from Mozambique was more susceptible than the local material.
- A project proposal (ref 961862) entitled "Selection and multiplication of superior germplasm **resistant to anthracnose disease** and improvement of apple by-product technology" was submitted to the European Union in 1996 by Instituto de Investigacao Cientifica Tropical, Lisbon and other institutions, to be undertaken in Europe, Guinea Bissau and Guinea. The title and contents would suggest that anthracnose was sufficiently important to warrant a breeding programme to develop germplasm resistant to anthracnose disease. (The project does not appear to have gone ahead however).
- Anthracnose was the leading item on the list of diseases that were considered the most important on cashew, according to the Plant Protection Department in Guinea Bissau and Camara and Vayssie (1996) list it as one of the principle diseases in Guinea Bissau.
- The Cote d'Ivoire questionnaire lists anthracnose as a significant disease. The Guinea questionnaire states that "The disease that is most widespread is anthracnose (*Colletotrichum gloeosporioides*) which attacks the aerial parts (stems, leaves, flowers and fruits). Its action in Guinea is <u>not very important</u>, those few trees identified are cut and burnt."

There are two possibilities to explain this apparent contradiction and these are:-

1. 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.
2. Field workers have confused other types of damage for anthracnose, leading to mis-identification.

Certainly during the current survey there were a number of occasions where other types of damage were attributed to anthracnose, e.g.

1. Jassid damage at Boke (by extension workers)
2. Sucking pest damage (by a senior research worker in Guinea Bissau)
3. Sucking pest damage (by researchers at Kankan)
4. Fire damage - a number of times

Obviously the situation is not entirely clear and is further confused by the disease shown in Photos. 16, 17, and 18 (Vol.2). This was quite prevalent in the Dabola/Kankan area of Guinea and around Odienne in Cote d'Ivoire. This disease which 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 and *Colletotrichum gleosporioides* (*Glomerella cingulata*) and *Phomopsis anacardii* were identified. There are a number of possible explanations:-

1. *Colletotrichum gleosporioides,* which is common in the soil and on other plants was present on the leaf but not active or pathogenic to the cashew leaf (i.e. accidentally present)
2. 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.
3. Pathogenic *Colletotrichum gleosporioides* was present before but due to unfavourable weather conditions it did not develop fully.

If explanation number 3 was correct, then it would have been expected that some fully developed anthracnose (black lesions) would have been seen somewhere in the areas where this disease was found, but none was seen. Whichever explanation is correct, the fact remains that anthracnose was not negatively affecting yields and hence was only of minor importance in 2001. However, it must be emphasised that further work is urgently needed on this issue.

Phomopsis anacardii is not considered to be a significant pathogen of cashew.

In East Africa (where powdery mildew disease is the main 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, more worrying was the fact that the disease had spread to local tall trees.

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 due to environmental, cultural or other reasons. However, strict quarantine regulations must be maintained or instigated if they are not already in place, when importing planting material especially from outside the region (see visit to SPCIA plantation, page 2, Annex 1).

6.3 *Cephaleuros virescens* (red or rust coloured algae)

This algae was identified by IMI from cashew leaves collected from the Accra region of Ghana at the time of the regional workshop in May 2000 and seen at various places during the survey, for example on the farm of Mr. Kwaku Kra at Koase, Ghana. It was also listed as one of the most important diseases on cashew according to the Plant Protection department in Guinea Bissau.

This algae is a common parasite of evergreen perennial crops and is not considered to be a constraint to production.

6.4 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 was present, then this is 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 the above observations, PMD was second on the list of the most important diseases on cashew according to the Plant Protection Department in Guinea Bissau and Camara and Vayssie (1996) list PMD as one of the principle diseases in Guinea Bissau..

For reference PMD is described below.
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 which becomes necrotic and causes the flower to abscise. Badly infected panicles where buds have abscised, appear stunted and grey in colour (compare with "naturally drying flowers, Section 7.1). Infected apples lose their bright colours, becoming cracked and shriveled 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.

6.5 Other minor disease problems

6.5.1 Secondary diseases

On the farm of Mr Coulibaly Yacouba in Seguela district, Cote d'Ivoire the main constraint was the puncturing of cashew apples, presumably by a sucking pest, followed by a secondary fungal invasion, which causes the apple to go bad and drop prematurely (Photo. 19, Vol.2).

A number of papers have been published by Olunloyo on secondary diseases of cashew – see Annex 6, Section entitled "Literature on Cashew in Nigeria".

The leaf spot fungus *Pestalotia conglomerata*, was listed as a disease of cashew by the Plant Protection Department in Guinea Bissau. It is unlikely that this leaf spot would be economically damaging.

6.6 Conclusions regarding pests and diseases

6.6.1 General observations

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 cashewnut 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 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.).

6.6.2 Basic Requirements for the future

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.

Not much previous work has been done on cashew pests and diseases and to help ensure that correct quantitative data is collected, a simple handbook should be put together and made available to researchers and field workers. This would collate all available and relevant information from both within the region and other parts of the cashew growing world where applicable and be updated as new knowledge became available. Such a handbook should be for the region as a whole in both English and French and eventually in local languages for extension workers and farmers. Inputs from the different organisations in the cashew network could help keep it up to date as new knowledge arose. A regional handbook used by all organisations would be of great benefit to help maintain harmony and synchronization of pest and disease data collected, and would act as a very much needed educational tool.

At the same time, methods of control would need to be researched for the economically damaging pests. Control measures should be practical, safe for use by resource poor farmers, show good economic returns and be environmentally sound.

It is appropriate to mention here the possible potential beneficial role of the predacious ant *Oecophylla*. In East Africa and elsewhere, *Oecophylla* has been shown to significantly reduce *Helopeltis* (sucking pest) damage. As a result of this, research has been conducted on ways of enhancing the territory of *Oecophylla* . Although not very common on cashew in West Africa, *Oecophylla* was seen in sufficient numbers to warrant research on its potential in the region (see Photos. 64 and 65, Vol 2).

Knowledge of cashew pests and diseases was generally very limited among field workers. Also farmers usually could not distinguish different types of damage or say what had caused it.

6.6.3 Summary of pests and diseases

A large number of trees were observed at a large number of sites in the main cashew growing regions of 5 West African countries, at about the most critical time in the production cycle, i.e. at the time of flowering /nut set. The incidence of pests and diseases is most critical at this time. The major conclusions are:-

- Insect pests are causing serious economic loss to farmers in some areas, while diseases appear to be of much less importance generally.
- Hemiptera sucking pests and thrips are probably the most economically import pests.
- Only tiny amounts of what might have been anthracnose were seen.
- Other types of damage were incorrectly identified as anthracnose.
- No powdery mildew disease was seen at all.
- More quantitative data on the economic status of pests and diseases is required.
- Pest and disease knowledge transfer to field workers and farmers needs to be radically improved.
- A cashew pest and disease handbook needs to be published for the region as a whole.

- Collection of quantitative pest and disease data and development of control methods should be synchronized over the region.
- Work on enhancement of natural control of sucking pests should commence.
- Quarantine procedures need to be either put in place an/or strictly adhered to.

7. Environmental constraints

7.1 '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. Photos. 20 and 21 (Vol.2) show examples of such mature, dried, flowering panicles; often entire trees are affected like this. This problem is **not** caused by any disease.

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 genetical, environmental, lack of pollination, rainfall during flowering or nutrient deficiency.

The presence of dried flowers was seen quite frequently and reported as a problem by a number of farmers. Some examples, drawn from Annexes 1 and 2 are given below: -

1. On the farm of Mr. El Hadj Anabumane near Kankan, Guinea, many new plants were suffering from a high proportion of dried panicles (Photo. 20, Vol.2), pale leaves and leaf disease.
2. At Atebubu, Ghana, Annex 2 states – "Other problems experienced included thrips, sucking pest damage (both minor) and the drying of a high percentage of panicles. The latter could be due to a number of factors e.g. nutrient deficiency, genetics, lack of pollinators, weather conditions".
3. Drying of flowers was significant on the farm of Mr. Alhassan Salifu near Cheyohi village, Ghana.
4. At the meeting with a farmer group from Cheyohi village, Ghana, the drying of flowers caused by insects/midges was reported as one of their major problems.
5. At the meeting with farmer groups at Ochaja sub-station, Nigeria, one of their main problems was the drying of flowers as a result, they thought, of the harmattan winds. The harmattan (cool, dry winds from the north east) were blamed for the drying of flowers. One farmer gave the following example - he normally harvested up to 50 bags (90 to 100kg each) but for the last 2 years when the harmattan has been bad, production had dropped to only 12 bags or a quarter of the expected yield.
6. On the farm of Mr Abou Alhadji Uba, Lafia, Nigeria, panicles on some trees had dried out and were unproductive, whilst other trees were bearing well.

During the survey in Nigeria, the harmattan was blamed for a number of problems, but the drying of flowers was the most frequently mentioned by farmers. However, as example 6, above shows, in one location it was apparent that the seriousness of dried flowers can vary dramatically from tree to tree. Sardinha *et al* (1993) reported in Guinea Bissau that "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." According to Mr. Adebola, the harmattan actually benefits some tree crops like mango and oil palm, but for cashew the situation is still unclear.

This problem of flowers drying out giving no production is sufficiently serious and widespread to warrant further research.

7.2 Deficiencies

Symptoms of nutrient deficiency were only seen occasionally and the symptoms displayed were similar at all sites – mottled (like marble) yellow and green leaves (Photos. 22 and 23, Vol.2). This was thought possibly to be a Nitrogen and/or Zinc deficiency but a precise diagnosis would require leaf and soil analyses.

The sites where these symptoms were seen were Atebubu, Ghana where the trees were exhibiting widespread yellow spots on the leaves (see Photo. 22, Vol.2); the farm of Mr. Alhassan Salifu near Cheyohi village, Ghana, where many of the trees had an unhealthy appearance due to yellow mottled leaves; and at the "Cashew Processing Industry Farm, Iwo, Nigeria (Photo. 23, Vol.2).

7.3 Fire

7.3.1 Fire damage to cashew

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, see Annex 1 and 2 for details. Below are some of the examples of fire damage actually seen by the survey team.

1. On the farm of Mr. El Hadj Anabumane near Kankan, Guinea, fire destroyed 800 recently planted seedling cashew plants in early January 2001, just before the survey visit.
2. Mr. Sumani Alhassan (Libga village, Savelugu/Namton district. Ghana) was so worried about fire that he stayed on the farm, day and night, in order to try and prevent outbreaks. He had made fire breaks but he did not have the resources to weed the whole area. According to him, fires were started for a number of reasons, (1) to enable the hunting of small mammals, (2) accidentally, (3) because of grudges, (4) to increase new grass for cattle and (5) to remove weeds ready for land preparation.
3. At "Cross River State Cashew Project Farm" (Nyanya, Cross River State, Nigeria) an estimated 50% of the new plantation had been lost to fire and will require replanting. To try and reduce the risk of fire, farmers are allowed to intercrop.
4. A devastating fire in late December had totally destroyed about 80% of the 250 ha of cashew (Photo. 28, Vol.2) at "T. Y. Acres Farm" (Takum, Taraba State, Nigeria). Most of the cashew will probably survive but there will be no yield from the burnt trees this year and possibly next year and many branches will have been killed. The outbreak was impossible to control even with 25 men and two tractors with water tanks, as strong harmattan winds assisted the fire. Fire was an annual problem on at least part of the farm. Photo. 27 (Vol.2) shows trees which have been repeatedly damaged by fire and exhibiting many dead branches.
5. The farm of General Jerry Useni (near Gwagwalada, Federal Capital Territory, Nigeria) was a large farm, part of which was planted with cashew, but due to the annual round of bush fires much of the cashew had been permanently lost. On this visit, the remaining cashew had again been burnt (Photo. 29, Vol.2). As a consequence of annual fires the farm has reverted back to growing annual crops and diversified into cattle, fish ponds and ostrich production. The owner was rarely on site.
6. Last year fire damaged 50% of Allam Agro-Allied Farm, (Oyo, Oyo State, Nigeria). So far this year there has not been a problem, but according to the manager, if cattle herders go through the farm then they would set fire to it. Fire breaks had been made around the outside, tractors had slashed between the trees and hired labourers slashed under the canopies. The cut grass and weeds were just left lying on the ground, so if a fire did start, the damage could still be substantial.

One of the factors contributing to the fire hazard at the above plots/estates, is that often there is no other cashew in the area, and so the plots are isolated. Consequently, 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 almost automatically brought under control. An example of this is the Korera Farmer Association (Boke, Guinea) which has a constitution and 198 members who contribute GNF 1,000 per year. The association has already introduced measures to control bush fires, which in the past have caused much damage to cashew fields. Now, fire is not one of their major problems.

7.3.2 Fire and the environment

The preceding section has described the effects of bush fires on cashew plots and the loss of income to the numerous farmers affected was substantial. In addition to the 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 top-soil can also be eroded, leaving less and less fertile land.

On the drive from Gaoual to Dabola (Guinea) we passed through large areas of land which had been burnt by bush fires, some of it to improve grazing for cattle, some of it for gaining access for clearing trees, either, for charcoal or perhaps future farm land (see Photos. 24, 25 and 26, Vol.2). Similar scenes of vast areas of total devastation due to bush fires were encountered when driving to Seguela in Cote d'Ivoire. Ghana and Nigeria had similar problems.

Annual bush fires contribute to a decline in biodiversity and biomass, release a considerable amount of CO_2 to the atmosphere and so contribute to global warming. Various human activities, for example, 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.

Much of this non-farm land where bush fires were rampant, would be suitable for growing cashew. Not only would cashew provide cash income but it could play a crucial role in preserving the environment by removing the need for annual bush fires and the devastation that follows. Also the growing of tree crops and improved cultivation of the soil can actually sequester carbon, which is basically the redistribution of carbon **from** the atmosphere to other reservoirs of carbon.

Young (1997) suggested that the wider adoption of agroforestry could help to reduce the build-up of atmospheric carbon dioxide and other greenhouse gases which contribute to global warming (Dixon *et al*., 1994; Schroeder, 1994; Dixon, 1995, 1996). Possible means by which such a reduction could come about are:

- taking up carbon into trees on farms;
- increasing soil carbon (carbon enters the soil as roots, litter, residues and animal manure);
- indirectly, by reducing pressure for forest clearance.

7.4 Overcrowding of trees

On many farms visited the cashew trees were overcrowded; Annexes 1 and 2 give numerous instances of overcrowded cashew plots. Spacing was sometimes down to 3m, even the large, original, Brazilian common trees at the CRNA research station at Lataha, were planted at an interval of 4m. 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 the farm of Mr Traore Vamogognima (Seguela district, Cote d'Ivoire). His farm was 3.75 ha in size and was planted closely spaced over the years 1987, 88 and 89. 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 are overcrowded. Because the canopy was contiguous there were no weeds. He only had to control the weeds around the periphery of the plot where fire from outside of the plot 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 criteria are valid:-

1. land is plentiful,
2. labour is limited and/or expensive
3. **diseases are of little importance** (high density planting often exacerbates disease problems)
4. insect pest problems are not made worse by high density cashew trees.

A number of farmers commented that they preferred a dense cashew stand so that they don't have to weed. When more quantitative data is available, a rigorous economic analysis should be done on high versus normal density planting.

7.5 The need for quantitative yield data

There is an important need for a database of farmers' yields to help:-

1. To determine what the potential yield of cashew is in different areas and hence estimate its profitability and likely attractiveness to farmers.
2. Clarify cashew production constraints.

The reasoning behind **why** this information should be collected originated from the following observations, (NB such 'snap-shot' observations using farmer recall are likely to have some error associated with the data, nevertheless, approximate estimates are still useful at this stage) :-

1. In the village of Cheyohi (Ghana), last year Mr. Alhassan Salifu harvested only 40 kg from 10 acres of 6 year-old trees (<10kg/ha) and Mr. Alhassan Tia planted 4 acres in 1995 and harvested 15kg (approx. 9kg/ha), both yields were very low yield indeed.
2. The cashew of Mr Sumani Alhassan (Libga village, Savelugu/Namton district, Ghana) yielded 320kg from 3 acres of 12 year-old trees (256kg/ha) and 160kg from 8 acres of 7 year old trees (48kg/ha). Again yields were low, but according to Dr Yidana (UDS), this was one of the better farms in the area.
3. Mr Yaya Umoru, Ochaja, Kogi State had a 5 acre block of 12 year-old cashew and another 55 acre plot of 11 year-old trees. From the 55 acres he harvested approx. 30 bags of between 90 and 100 kg. This converts to roughly 3000kg from 23 ha or 130kg/ha, which is low.
4. Last year the yield from " T. Y. Acres Farm" (Takum, Taraba State, Nigeria) was approx. 275 bags (90kg per bag) from about 220 ha of unburnt cashew, equivalent to 112.5kg/ha, which is low for 9 and 10 year old trees. The plantation was not making

a profit, which is not surprising considering the low yields/ha, frequent fires and a range of highly paid staff (accountants, auditors etc.). As a result, they have stopped planting cashew even though there is much land still available.

5. Last year Allam Agro-Allied Farm (Oyo, Oyo State, Nigeria) only produced 26 tons from approx. half of the plantation (fire damaged the rest), which equates to about 118kg/ha, which is low.

In all of the above cases, there was no immediately obvious reason for the low yields; since the yields were for the previous year, the survey team obviously did not see the condition of the trees and thus were unable to put forward a possible reason for these low yields.

The question of why the above plots and no doubt others, produced such low yields, urgently needs further work. More quantitative yield information is required from a representative number of farms over a number of years from all of the main cashew growing areas, along with information on possible pests and diseases and any treatments given.

7.6 Conclusions

The problem of flowers drying out with no production is sufficiently serious and widespread to warrant immediate research. Progress on this topic could be made relatively quickly, at least by 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. 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.

After the literature review various strategies need to be evaluated on farm, for example:-

- where tractors are available, cost sharing strategies might be worked out to make fire breaks
- a hand operated petrol rotavator might be useful for making fire breaks
- growing certain crops around the periphery of cashew plots, that either remain green or ones normally grown and that are kept clean of weeds, need to be explored.

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 in the past 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. A selection of as similar as possible paired plots could be analysed, one plot low-density and the other high-density cashew.

Finally, more quantitative yield information is required from a representative number of farms (preferably over a number of years) from all the main cashew growing areas, in order to determine the yield potential and profitability of cashew in the different areas. This would be a matter of identifying a number of representative villages and then selecting a number of farmers, perhaps randomly from a register of cashew farmers, and then collecting only reliable past yield information and monitoring future yield data more thoroughly.

8 Germplasm, breeding and planting material for farmers

8.1 Introduction

We now have a reasonable idea 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 as produced in the local environment. (It is unfortunate that we can not reasonably expect the breeders to produce fire-resistant cashew plants!)

There follows a review of existing germplasm, and what breeding work has been carried out - both on-station and off-station - and vegetative propagation trials, according to country. The sub-heading "Breeding Research" is used in its broadest sense, to include selection of useful looking trees.

8.2 Guinea

8.2.1 Research station sites.

The "original" germplasm collection at CRAF (Foulaya) was a group of 61 old trees, planted as seed in the 1950s during colonial times; the trees, although planted at a good spacing, are now somewhat overcrowded (Photo. 30, Vol.2). 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. Many of the trees were flowering well, there was no apparent disease and insect damage was minimal. Characterisation of nuts from these trees has started, see Table A3.6 in Annex 3; average nut weight for individual trees in this collection ranges from 2.5g to 14.1g and the best 14 trees have been identified using various selection criteria. These selected trees have nut weights ranging from 6.1g to 14.1g, with an average for the 14 trees of 9.1g (see Table A3.7, Annex 1).

A new germplasm trial had started (Photo. 31, Vol.2). All material had been planted from seed and therefore all the new plants were half-sibs and not clones of the original mother trees. New material included seed from:-

- the best trees in the "original" collection (see Table A3.7),
- selected mother trees from Boke region (Photo. 32, Vol.2),
- Brazilian seed originating from a forestry project (nothing more is known about this source).

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

8.2.2 Recently introduced material.

The only new plant material of known provenance recently introduced into Guinea was seed imported from Brazil by SPCIA. The seed, from Brazilian clones CCP 09, CCP 1001 and CCP 076 was planted at Mafrinya (Forecariah). The seeds were planted in polythene pots on 22/11/00 and germination started after 11 days which is about normal. Unfortunately only a small percentage have germinated after about 7 weeks, see Table A1.1 in Annex 1. The pots were kept in a locally made shade house and watered in the morning and evening, which was excessive and probably contributed to the very low rates of germination. It was

apparent that only plants at one end of the shade house had germinated (Photo. 33, Vol.2), which was somewhat strange but there was no immediately obvious reason for this that the survey team could elicit. Those seedlings which had germinated, looked healthy.

It should be noted that these seeds were imported without any quarantine procedures. This is potentially **very dangerous** as Brazil has cashew pests and diseases, which are not found in West Africa. Before importing more cashew seeds from other countries, especially outside of West Africa, suitable quarantine procedures must be in place.

8.2.3 Germplasm demonstration plots.

SPCIA demonstration plot (Denken district, Boke). The objective of this plot was to demonstrate to farmers a range of germplasm and how best to grow cashew. However, the plot was in very poor condition, many of the trees had died and many were engulfed in weeds so tall that finding the plants was difficult – hardly the type of demonstration plot to show farmers. In fact on a neighbouring farm, cashew was growing much better.

Unfortunately much of the potential opportunity regarding evaluation of different germplasm has been lost:-

- Seed from selected mother trees in the Boke region had been mixed up, so it was impossible to associate any superior performing trees with the original mother tree.
- Seed from Brazil had no information at all about where it came from, or about the trees involved.
- Many of the lines of seed from individual trees in the Foulaya germplasm collection have been lost.
- There is no replication, even at a simple level.
- Most of the lines have no labels informing of their identity or provenance.

Another example was at the farm of Mr Moustapha Keria at Dabola. Seed for this particular plot was provided by the Extension Service for evaluation purposes, however, nobody, at least in Dabola, knows where the seed came from! Without this information, any evaluation can only be of limited value. Seeds were germinated in plastic bags prior to transplanting into the field at a spacing of 10m x 10m, in 1999. The plants are growing well.

8.2.4 Farmers and germplasm

One of the main constraints reported by most farmers in Guinea was lack of good planting material, see Annex 1 for numerous examples.

The situation with regard to cashew planting material for farmers was that everything was planted as seed from either:-

- An unknown origin.
- Purchased locally from another farmer.
- Obtained from another part of Guinea, e.g. Boke or Mandiana due to greater production in these areas (perhaps selected on nut size).
- Obtained from Guinea Bissau or Cote d'Ivoire for no particular reason other than that production in these two countries is more substantial than Guinea.
- Obtained from selected "mother trees".

At present there is no strategy for planting material as none of the above options are guaranteed to provide improved trees. There is no evidence that Boke, Mandiana, Guinea Bissau and Cote d'Ivoire have any better planting material than the farmers have already. The issue of selected "mother trees" is discussed below.

8.2.5 Vegetative propagation

At Foulaya, research technicians have started practicing 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 constituted a clone.

8.2.6 Breeding Research

A start has been made with:-

1. characterising nuts from the "original" germplasm collection
2. selecting possibly superior trees from the "original" germplasm collection and "mother trees" from farmers fields and planting in a new trial. See below for comments regarding "mother trees".

(NB A few trees on the farm of Mr Sidiki Diakite (Maletoumanina district, Sous Prefecture Saladou) were producing large nuts and yielding well and would be worth cloning for evaluation.)

8.3 Guinea Bissau

8.3.1 Research station sites.

None were visited during the survey.

8.3.2 Recently introduced material.

Local researchers 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 – see Annex 1). USAID wanted to import cashew from Brazil but this was refused on quarantine grounds.

8.3.3 Germplasm demonstration plots.

Not aware of any.

8.3.4 Farmers and germplasm

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

Initially, 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.

8.3.5 Vegetative propagation

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. This is rather ironic considering that in 1990 there was a 3 year European Union funded project to develop sophisticated *in vitro* techniques for cashew tissue culture and propagation. All of the *in vitro* work was carried out in European Universities and much still needs to be researched to make cashew tissue culture a viable proposition. Needless to say this project has had virtually no beneficial impact in Guinea Bissau, the researchers spoken to had no idea about the project. See Section 8.3.6 "Research", for more details.

8.3.6 Research

According to Eng. Quintino da Costa (Presidente) and Lourenco Abreu (Coordenador Nacional da Pesquisa) at INPA (Intituto Nacional de Pesquisa Agraria), Guinea Bissau does not have a cashew breeding programme and does not have a trained cashew breeder. Given the importance of the crop for the country's economy and as West Africa's main producer of cashew, this is surprising. The project below does not appear to have helped in this matter of institution building.

The European Union funded a 3-year research project entitled "Selection of superior genotypes of cashew (*Anacardium occidentale* L.) in Guinea Bissau and the development of *in vitro* techniques for their propagation" (Contract no. TS2-A-0167 P). The propagation part of this project has already been mentioned in Section 8.3.5. 42 trees were selected from the regions of Biombo, Oio, Bafata and Bolama. Selection was based upon the colour, shape and size of the apple or pseudo-fruit. Secondary characteristics were also measured, e.g. apple size, weight and astringency, nut size, branching habit, flower ratios and precocity. Yield was not taken into account and nut weight was only a secondary characteristic, although these are the 2 most important parameters as far as farmers are concerned. The fruits from these 42 trees were then grouped into one of 7 classifications based primarily on the colour, shape and size of the apple. For example Group F had the following characteristics:-

1. Apple – periform, yellow, big size, very astringent and consistent
2. Nut size – big
3. Branching type – extensive.

The classification based upon apple characteristics (periform/cordiform, red/yellow, big/small, astringent/not astringent) seems very rudimentary. It is perhaps not surprising that when selections are based primarily on **apple** characteristics, nut weights are generally very small; 5 out of 7 of the groups had mean weights ranging from 4.8 to 5.8g. The establishment of a clonal garden through well established grafting techniques proved a failure. Ironically, this project concluded that "Cashew nuts' commercial grade in Guinea Bissau is poor due to its small size, this warrants a clear action directed to provide improved material with higher commercial potential". Unfortunately this project did very little to assist in this important matter.

According to Camara and Vayssie (1996) the only distinction with regard to cashew types or "varieties" was between the local variety (caju de terra) with red apples and caju de Mozambique with yellow apples. The former has sweet apples and small nuts, while the latter has astringent apples and larger nuts.

The reports by Camara and Vayssie (1996 and 1997) provide considerable nut-weight data, some of which is summarised in Table 11.

Table 11. Percentage distribution of raw nut weights from Guinea Bissau
Data from Camara and Vayssie (1997)

Category >	**caju**	**tres petite**	**petites**	**moyennes**	**grandes**	**Tres grande**
Weight range	<3,35 g	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
1996/97	6	28	54	12		0
Average	**8**	**30**	**52.5**	**9.5**		**0**

Table 11 shows that from the average of the two seasons' samples, 38% of nuts weighed less than 4.5g, the grade termed 'tres petite' or very small. It is estimated that around 60% of raw nuts weigh less than 5.00g (Camara and Vayssie, 1996). The fact that nuts from Guinea Bissau are generally small was reported at the 2001 World Cashew Congress in India and yet, in spite of their small size, they command a small premium on the international market. The reason for this, is the high percentage kernel out-turn of nuts from Guinea Bissau. This is probably nothing specifically to do with Guinea Bissau, but that generally the smaller the nut the higher the percentage out-turn.

8.4 Cote d'Ivoire

8.4.1 Research station sites.

The CRNA germplasm collection at Lataha consisted of 36 trees, planted in one row in 1984, with a spacing of 4m between trees. The history is that the seed for these trees originated from one tree in Brazil (Photo. 34, Vol.2) 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. Mr Jean Baptiste Djaha has just started to evaluate this collection and has found that only 4 trees out of the 36 produced a yield of > 8kg/tree and a percentage kernel out-turn of >20%.

It should be noted that "Brazilian common" trees are very large and with only 4m spacing between the CRNA trees, yield data cannot be very accurate, particularly as a potential indicator for further planting. Obviously 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 a new block of 45 trees in 1997 at a spacing of 8m x 6m (a spacing more commonly used for dwarf material).

8.4.2 Recently introduced material.

No new cashew material has been introduced into Cote d'Ivoire recently.

However, some time ago, seed from Brazil, presumably from large common trees, was imported and planted on an estate at Badikaha (near Korghogo). The SODIRO cashew plantation (100 ha) which 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.

8.4.3 Germplasm demonstration plots.

None were seen.

8.4.4 Farmers and germplasm

Since 1995 ANADER has been selecting seed from good trees on the basis of colour of apple, yield, tree structure and size of nut. People have complained that nobody could tell the different varieties apart - this is not surprising however, since there aren't any different varieties. The issue of planting material was very confused in people's minds, and nothing is being evaluated on farm and very little on station (see above).

A very valuable and informative visit was made to the farm of Mr Kone Koulouba in (Koro Ouleu village, Cote d'Ivoire). In 1992, the farmer started to plant an additional 4 ha of cashew with assistance from ANADER. The seed for this block was **all** taken from one supposedly superior "selected mother tree" (Photo. 35, Vol.2) and as is often the case, this selected tree was growing under ideal environmental conditions, i.e.:–

- 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 a typical example of "mother tree" selection found in many countries. (NB "Selected mother tree" often means a local tree with supposedly superior qualities like yield or nut weight.)

8.4.5 Vegetative propagation

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

8.4.6 Breeding research

Very little research work has been undertaken on cashew breeding in Cote d'Ivoire as evidenced by the very short literature list at the end of Annex 4. This is not surprising considering that Mr Jean Baptiste Djaha is the only full time senior cashew researcher and that he was transferred from working on papaya only a year ago.

8.5 Ghana

8.5.1 Research station sites.

The UDS/SARI germplasm collection at Tamale consisted of trees grown from seed taken from 60 local "selected mother trees" (Photo. 36, Vol.2). Eight seeds from each of the 60 mother trees were planted in one replicate in 1997. Table A5.12 in Annex 5 provides some information on the first 30 accessions. Note that the nut weights given are from the original mother trees and not from the progenies planted in this trial; it is apparent that some of the mother trees are producing nuts of very low weight.

The block was reasonably well maintained but it was unfortunate that only 1 replicate was planted. Also more information needs to be obtained from the original mother trees.

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.

8.5.2 Recently introduced material.

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 is being imported in 2001; this material is being sold to the farmer. "Jumbo" nuts come from one farm in Eastern Nigeria (Kosoni Farm, Oro, Kwara State - visited later in the survey, see Section 8.6.2). 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 plantation at Sampa in Ghana. Now they are selecting mother trees from their own plantation based on yield and nut size. One mother tree was seen, and this was isolated on the edge of a block, which can give elevated yields

due to reduced competition. When discussing the problems associated with mother tree selection (see 8.4.4, 'Farmers and germplasm'), it was pointed out by the manager that a few of the selections were within blocks growing under normal conditions of competition with other cashew trees. It would be useful if research could obtain clones from these selected trees for evaluation. It was also useful to note that trees originating from seed from India were more susceptible to damage by thrips.

8.5.3 Germplasm demonstration plots.

None were seen.

8.5.4 Farmers and germplasm

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, again from selected local mother trees. All of this new planting will be very variable and much of it without any particularly desirable qualities.

Mr Kwaku Kra (member of Koase Cashew Farmers Association) had 2 acres of trees that originated from Brazilian dwarf seed material obtained from ADRA, the trees are now nearly 3 years old. A few trees had been killed by fire. It is worrying that seed from outside the country is being sold to the farmer prior to any evaluation under Ghanaian conditions. For example, Brazilian dwarf material, although having some useful characteristics, is particularly susceptible to anthracnose, *Helopeltis* and fire. There is also the possibility that under Ghanaian environmental conditions it performs worse than in Brazil. Obviously cashew development workers are enthusiastic to get things moving, often when there is inactivity in other organisations, but **evaluation must take place** to ensure the farmer will not eventually be negatively affected.

8.5.5 Vegetative propagation

No vegetative propagation of cashew is being undertaken.

8.5.6 Breeding Research

As already mentioned there is some evaluation of local "mother tree" selections, but little else. It is only recently that the issue of cashew research has been given any priority by the government.

8.6 Nigeria

8.6.1 Research station sites.

The CRIN sub-station at Ochaja was home to a number of breeding trials:-

1. '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 4 trees (i.e. 4 seeds from one tree) replicated twice, Photo. 37, (Vol.2) shows a map of part of the trial and Photo. 38, (Vol.2) shows one of the trees in this trial. 18 types have been selected for farmer planting.
2. Brazilian "jumbo nut" trial – these nuts were obtained from Kosoni Farm (Oro, Kwara State - see Section 8.6.2). They were graded according to weight and then the whole 7ha block was planted according to nut weight, that is the smallest nuts at one end rising to the biggest nuts at the other (Photo. 39, Vol.2). Spacing was 9 x 9m. The nuts were <u>not</u> from selected trees.
3. Millennium block – Brazilian jumbo type nuts were being evaluated at different spacings, 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.

4. Other trials were present and some of the older ones had been earmarked for upgrading trials.

At another site, half-sibs of 25 locally selected "mother trees" were being evaluated, again 4 seeds from one tree were planted per plot and replicated twice.

8.6.2 Recently introduced material.

There does not appear to have been much new planting material introduced in very recent years, but 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), see below.

On Kosoni-Ola Farm, an area of 350 ha was planted entirely with Brazilian "common" seed imported from Brazil, Photo. 42 (Vol.2) shows an example of one of the trees. Planting started in 1986 and was finished by 1988 and then gapping (filing in of spaces) continued. The total farm area was 500ha. Nut size was variable but a high percentage of trees were giving a very good nut size (Photo. 43, Vol.2). 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 200kg/ha. More could be done to improve productivity, e.g. top-work unproductive trees, improved maintenance and more efficient harvesting. However this type of tree **needs to be evaluated fully**, before recommending it to the farmer, e.g. for yield potential per ha, kernel weight, percentage kernel out-turn, etc. The main observation was that there appeared to be no anthracnose symptoms on the trees, although there were black oily lesions on the nuts (Photo. 66, Vol.2), which needs further investigation. In Brazil this type of tree would be exhibiting severe anthracnose (Photo. 15, Vol.2), but here, there was none.

8.6.3 Germplasm demonstration plots.

None were seen.

8.6.4 Farmers and germplasm

It was reported that CRIN has distributed 1.5 million seeds from selected trees, for planting by farmers. The present cost to the farmer of this seed is N50/kg. They also distribute seedlings (CRIN seed raised in poly-bags) for N 5 per seedling but the actual cost is N 16, so these are heavily subsidised. They were only selling a small number of seedlings due to high transport costs; as a result more than 70,000 seedlings were unsold last year.

At Awoniyi farms (near Kabba, Kogi State) the planting material was seed purchased from CRIN and the resulting trees appeared to be producing larger nuts than those produced by nearby indigenous cashew trees, but the latter were very small indeed (see Photo. 44, Vol.2). However at Lafia (Nassarawa State) the seed from CRIN were about 5 to 6g in weight (and some were even smaller) and this was smaller than the local nuts seen at the office of extension. Planting in Nassarawa State was either using seed from local trees or from CRIN and unfortunately last year a proportion of the CRIN seed material was discarded due to lack of drying.

The CRIN seed comes from selected individual trees and because of out-crossing, it is likely to be very variable. A poly-clonal 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

At one of the very first cashew plantations planted in the early 1950's, (Premier Cashew Industry Farm at Oghe, Enugu State), some of the trees still looked very good, giving high yields of possibly up to 50kg/tree and medium sized nuts (Photo. 40, Vol.2). Seeds from selected trees from here were used in CRIN's 1977 germplasm collection. Both this plantation and the Premier Cashew Industry farm at Orji River, acted as sources of seed for farmers when cashew was commercialised.

8.6.5 Vegetative propagation

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

8.6.6 Breeding Research

Nigeria has a long history of cashew breeding research, as demonstrated by replicated germplasm trials planted in 1977 and a small number of papers published in regional journals – see the literature section in Annex 6.

8.7 Conclusions

There is a tremendous amount of enthusiasm for cashew by farmers (and the authorities) in all countries and the farmers are expanding their cashew often with little or no support. Only Nigeria has seed for sale which has been evaluated to a certain degree. Even in Nigeria, the CRIN seed could be substantially improved.

The universal complaint is lack of good planting material, Annexes 1 and 2 are replete with examples of farmers and associations complaining that one of their main constraints is lack of good planting material. Much needs to be done with regard to selection, introducing new material, establishing germplasm trials for the short term, 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 must have the highest priority.**

A related area which 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 are having to use half-sib seeds all the time, which introduces more variability into the trials. With cashew being such a variable crop anyway, this is undesirable. Institutes could develop the technique of vegetative propagation on their own, adapting knowledge from other crops, but to make the process faster it is proposed that a workshop is given by an experienced cashew grafter, in order to transfer the technology that much more quickly and reliably. One or two scientists and/or technicians could attend the workshop from each country.

Finally, it must be emphasised that **Brazilian dwarf trees would be entirely unsuitable** in areas prone to bush fires.

9 Research capacity

9.1 Introduction

With the exception of Nigeria, generally speaking very little cashew research on all topics has been undertaken in the countries visited. Breeding research has been discussed above. This lack of research is not really surprising, as it reflects the 'newness' of cashew in the

region and that in some countries, government research organizations have only recently either been mandated or funded to work on cashew. Funding is a critical factor in all countries, with budgets extremely tight or non-existent.

Research capacity for each country is reviewed separately, but conclusions are given for all countries together at the end of the section.

9.2 Guinea

There is only one full-time senior research person working on cashew, Eng. Souret Diaora (member of the survey team) and he is a general agriculturalist. He is supported by 3 full-time technicians. Over the past 3 years they have been gaining some experience of cashew. This small team is based at Foulaya, which is a 5 hour drive away from Boke, one of the main cashew growing areas, the journey to which involves an unpredictable ferry crossing. In view of this, it will be necessary to have at least one member of research staff based in Boke. At present, trained manpower is limited

Funding is extremely limited and has been in the range GFr 3 to 4 million per annum ($1,500 to $2,100 at the current exchange rate of GFr1,900 /$) since 1998; before that there was no budget specifically for cashew.

See Section “Research Capacity”, Annex 3 for further details.

9.3 Guinea Bissau

It was not intended to review the capacity for research in Guinea Bissau, but a few comments are given below.

At a meeting at Direccao de Estudos, Planificacao e Seguimento Politicas e Programas Agrarias the survey team were informed that Guinea Bissau has very limited research facilities and since 1993, has been severely financially constrained. Since the civil war ended in 1998, stability in the country has been a major problem, but nowadays things have improved somewhat.

According to Eng. Quintino da Costa (Presidente) and Lourenco Abreu (Coordenador Nacional da Pesquisa) at INPA (Intituto Nacional de Pesquisa Agraria), Guinea Bissau does not have a cashew breeding programme and does not have a trained cashew breeder.

Considering that cashew is the country’s main export crop, (70,000 tons of raw cashew nuts in 2000), the capacity for research appears undesirably limited.

9.4 Cote d’Ivoire

The CNRA (Centre National de Recherche Agronomique) station at Korhogo is responsible for cashew research. Presently there is only one full-time senior cashew research worker, Mr Akadie Jean Baptiste DJAHA (member of the survey team) and he transferred from papaya to cashew only one year ago. There is one full time cashew technician. Other scientists can be called upon to work on cashew from other programmes, for example, Dr Felix COULIBALY (member of the survey team), who is a pathologist for all crops. In-depth experience of cashew is very limited at the moment.

The country has been divided up into various ecological zones and the Korhogo centre is responsible for the savannah region, which normally receives between 1,100 and 1,300 mm of rain a year. There were 4 research programmes operating at Korhogo :-

1. Tree crops (mango, citrus, cashew and papaya)
2. Agro-systems
3. Sugar cane
4. Maize.

At present there is no specific budget for cashew and funds from the mango budget assist cashew research. See Section "Research Capacity", Annex 4 for further details.

9.5 Ghana

The Crops Research Institute (CRI) at Kumasi was recently given the mandate for cashew research. There are 7 well qualified senior scientists working part time on cashew, unfortunately only between 5 and 10% of their time is devoted to cashew. These scientists came from a range of organisations, see Table A5.8, Annex 5. Presently there is very little in-depth experience of cashew research.

The main constraint for cashew research is funding, in 1998, Cedis 23 million ($3,400 at the current exchange rate of Cedis 6,700 to the US$) was allocated to cashew research, but this has been the only funding.

At the Savannah Agricultural Research Institute (SARI) at Tamale, funding for research essentially stopped about 3 years ago. Salaries were paid but delays were experienced with even that. Funding from GTZ, a long term supporter of SARI, stopped in 1998 and now there are a few small DFID and American University collaborative projects. NARP funding finished in 1999.

There are 5 Zonal Research Committees, one for each agro-ecological zone in the country. Below the Zonal committees are district level committees, made up of farmers, extension workers, NGOs and 1 research person. These groups are supposed to define farmer's problems and pass them on to researchers, to ensure that research activities are demand driven. Obviously these district level committees in cashew growing areas should be of value in defining problems and constraints for cashew production.

9.5 Nigeria

Table A6.5, Annex 6 provides a list of senior research personnel of the Cocoa Research Institute of Nigeria (CRIN). The list is quite impressive with a good number of well trained scientists, however these scientists are responsible for research on 5 major tree crops, cocoa, coffee, tea, cashew and kola.

Funding for cashew research was in the region of between $2,000 to $4,000 per annum for 1995 and 1996, it then jumped to $20,000 and $28,000 for 1997 and 1998 respectively and then went down to $10,000 - $12,000 for 1999 and 2000.

See Annex 6, Section "Research Capacity" for more details.

9.7 Conclusions

In all countries (to a lesser extent 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.

Obviously institutional problems of this nature are not solved easily: some suggestions are given below.

- Cashew needs to have a clear priority within each of the government's National Agricultural Research System (NARS), otherwise it will be difficult to get people and funds.
- Government organizations will need to re-deploy people from other sections or employ new graduates to work on cashew. (Governments are often reticent to employ more personnel due to past over employment).
- For export crops such as cashew a small export levy can be implemented, the money collected should be made available for cashew research and development.
- Submit well thought out projects to funding agencies.
- Regional networking is one of the objectives of the STCP and can be a powerful approach to problem solving – this is discussed in more detail under "Recommendations".

It must be remembered 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 funding and ideally in terms of personnel too.

10. Potential Cashew Areas

It is only necessary to say that large areas of land suitable for cashew are available in all the countries visited, and so land would not be a limiting factor for a long time. This is purely based upon a visual assessment of the environment during the survey, 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 of 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 survey was 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.

11. Extension capacity - knowledge and technology transfer.

11.1 Introduction

A review of extension capacity is beyond the remit and TORs of this survey. However, observations from the survey and comments on this topic for each country should be of use for focusing on factors constraining production and future development.

Once knowledge or a particular technology has been developed either by research and/or farmer groups, and tested in on-farm trials and/or farmer trials and has proved successful, it is important to transfer this to the widest possible clientele. Without a good level of farmer adoption, the knowledge or technology is wasted.

11.2 Guinea

There are a total of 3,000 extension agents in the whole of Guinea for all crops and in 2000, a total of 15 extension agents were trained as tree crop specialists. SPCIA also have a small number of cashew extension agents.

In some areas farmers complained that they received no support from extension – see Annex 1.

11.3 Guinea Bissau

No observations were made on this topic.

11.4 Cote d'Ivoire

ANADER is the principle organisation responsible for extension activities. The personnel composition of the ANADER office in Monkono is given below:-

Chef du zone	1
Survey/statistics specialist	1
Association specialist	1
Specialist on professional organisation	2
Agricultural specialist (incl. tree crops)	2
Supervisors	2
Field extension agents	22

The Monkono office serves approximately 200,000 farmer households and this seems to be a typical arrangement for an ANADER office and a typical ratio of extension staff to farmers. So very approximately, each field extension agent has about 10,000 farmers to work with and obviously this is an impossible number with which to transfer new knowledge and new technologies.

11.5 Ghana

Both MOFA and NGOs carry out extension work, the NGOs ADRA, Technoserve and Cashpro are particularly active with cashew in some areas and in those areas the quality of service is quite good. Technoserve organised a trip to Nigeria for representatives of 5 cashew societies to see cashew activities there; these people then became extension agents to help other farmers.

11.6 Nigeria

Nigeria follows the T&V system of extension. It has had one multi-million dollar T&V programme financed by the World Bank (Phase 1) but Phase 2 has not materialised to date and now it would appear that already the extension service is lacking funds and is poorly resourced.

The lack of an effective extension service was frequently quoted by farmers as a major constraint and many new cashew farmers have had no support whatsoever - see Annex 2.

In Lafia (Nassarawa State) the extension service had156 Village Extension Workers (VEW's) servicing 220,000 farmer households, a ratio of VEW's to farmers of 1 to 1,403. A few VEWs had bicycles but the majority had no means of transport with which to get to their

clients. Without transport it is impossible to reach widely dispersed farmers. There were a total of 24 Subject Matter Specialists (SMSs), of which 4 were tree specialists. Extension services were paid for by the individual States. At least in this state, there did appear to be some collaboration between extension and research regarding cashew, but for other states there appeared to be little or no research and extension interaction.

11.7 Conclusions

The extension service for cashew farmers in most parts of all the countries surveyed is either:-

- Weak - extension personnel are present but are not fully trained with major gaps in their knowledge, for example regarding identification and treatment of pests and diseases.
- Limited in manpower, transport and/or financial resources
- Non-existent.

Extension is a very important and yet a very difficult and complex subject, especially when dealing with resource poor farmers that are often numerous and widely spread. 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 T & V system is characterised by the following:-

- 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 individual farmer's agro-ecological and socio-economic circumstances.

To try and overcome these overwhelming problems, alternative approaches need to be tried, for example:-

1. A knowledge based approach to extension has many benefits over simple impact points, this builds upon existing farmer knowledge 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.
2. Build and strengthen farmer associations to act as focal points for extension activities
3. Train farmers as extensionists as shown above (the Technoserve example, in 11.5). These farmers would still require regular supervision to ensure that they are not making mistakes and passing this on to others.

12. Farmer associations

12.1 Introduction

Farmer Associations were met in all of the countries and ranged from the small and informal to the large, National associations. Annexes 1 and 2 report on the outcome of a large number of meetings with farmer associations in all the survey countries; below are some of our experiences and comments that exemplify the general observations made.

12.2 Guinea

Annex 1 details a number of meetings with farmer associations. A good example was the Korera Farmer Association (Boke) which had a constitution and 198 members who

contributed GNF 1,000 per year. The association had already been instrumental in improving the situation with regard to cashew by introducing measures to control bush fires, which in the past had caused much damage to cashew fields. The elected officers had never been trained in skills useful for running the association and there was no external support. Such an absence of skills training may create problems in the future.

The meeting with the Dabola Cashew Planters Association was quite exceptional because it was the first time that we had met any women at any meeting or farm visit (Photo. 46, Vol.2). Therefore, some time was spent discussing problems specific to women farmers. Their main concern was to provide a future for their children and their main constraint was time due to all their other responsibilities of housework, food preparation and childcare. There were 138 members of which 58 were women. The Association's objective was to have 100 ha of cashew planted by the end of 2001 (they had 12 ha already planted). Cashew is a new crop in this area.

All of the Guinea farmer associations appeared to be very enthusiastic about cashew and were farmer generated (rather than imposed from the top), which is very good. None of the representatives have received training in the skills necessary for running successful farmer associations, although SPCIA has been trying to help. The elected representatives were generally the older, wealthier members of the community.

12.3 Guinea Bissau

A meeting was held with the President of the National Farmer Association (Associacao Nacional de Jovens Agricultores da Guinea Bissau) but the meeting did not promote a great deal of confidence in the organisation.

12.4 Cote d'Ivoire

Representatives from a number of large associations were met, for example the Bengueman co-operative, CEACI co-operative and CAWORO co-operative. These associations had up to 1,000 members or more, or covered a range of villages (e.g. the CEACI co-operative covered 60 villages), and included a range of crops (e.g. members of the CAWORO co-operative had 275 ha of coffee, >1000 ha of cocoa, 420 ha of cashew, 100 ha of cotton plus rice and maize).

The LEMISSA farmer co-operative was even larger than the examples above, with over 6,000 members covering 320 villages in the Department. Each village contributed CFA 10,000 and had a sub-committee (President, Secretary, treasurer, etc). One representative from each village sat on the sous-prefecture committee and each sous-prefecture had a representative on the LEMISSA board. This was a very different structure to all previous farmer associations encountered. The crops included cashew, mango, citrus, and cereals but NOT cotton. It was difficult to get a clear picture of what the association actually did for the farmer, but the following seemed to be part of the package:-

- It helps farmers with pest problems by negotiating with companies like Novartis for products.
- It works with ANADER regarding extension (although LEMISSA itself does not have any extension agents).

The village of Kogolo, which was visited by the survey team, was part of the LEMISSA co-operative but the farmers were **not** even aware of its existence! The President said that this was one of the difficulties that they need to overcome.

At the other end of the spectrum was the Masala farmers association, which was a very informal association, with no joining fee and no annual fee. The association received commission from the sale of cashew and last year this money was used to buy a balance, a very practical and useful action.

Also not all experiences with farmer associations were good. Mr. Fakoly Fofana **(**Monkono) was a member of a cotton association but had stopped growing cotton – the cotton and cashew harvests occur at the same time and since he was getting a better return on cashew, he had relinquished cotton. He also had problems with the cotton association manager, which, according to researchers and farmers, seems to be a frequently encountered problem for farmers. He wanted help to start a cashew association.

12.5 Ghana

Some of the farmer groups working with ADRA had obviously realised the benefits of group "power" and were trying to register as co-operatives, but the farmers did not like the word "co-operative" as it has bad connotations from the past with inefficient government co-ops; they prefer the word "association". There were difficulties regarding registration, i.e. various rules and regulations had to be satisfied, but ADRA had been helping with the problem. ADRA had run a workshop giving advice on how to run farmer associations.

12.6 Nigeria

Mr Umoru (Ochaja) belonged to the Nigeria Farmers Association but according to him, he derived no benefits from being a member. The joining fee was N 5,000.

At the meeting with about 20 representatives from different farmer groups at Ochaja sub-station, all the groups belonged to the Nigerian Farmers Association and the perceived benefits of membership were mixed. About 10% had received loans of about $50 and about 50% had bulked their nuts to negotiate a higher price. (It is likely that the representatives attending this meeting were the larger farmers and/or officials of the various groups and would therefore give a more positive response regarding the benefits of the Nigerian Farmers Association).

Many of the sites visited in Nigeria were large estates, but of the few smallholder farmers met, all of them belonged to the Nigeria Farmers Association, which seems to be a large and unwieldy organisation, unresponsive to the needs of small cashew farmers.

12.7 Conclusions

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 are 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 as for example found in Cote d'Ivoire. It is vital that training is provided as soon as possible, especially for the smaller, new, farmer-generated 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 strong 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.

13. **Diversification at the farmer level** (and risk reduction)

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, and 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 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 one 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 demand. However due to the long term nature of tree crops, production kept increasing and to make matters worse, all of the trees produced at the same time (there were no later varieties). Hence it was very difficult to sell 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.

The Monkono region (Cote d'Ivoire) was a big cotton growing area, but because of decreasing cotton prices and increasing cost of inputs, farmers were starting to diversify into cashew. Other crops of importance in the area included mango, citrus and a little coffee. Associations for cotton are starting to incorporate cashew.

Mr Lagazin Bamba (Kogolo village, Cote d'Ivoire) was intercropping citrus with cashew which in principle was a good idea. Unfortunately, in this instance, the 5 ha field of cashew and citrus was too overcrowded and the yield from cashew was being negatively affected. Photo 62 (Vol.2) shows another less crowded field of cashew and citrus. *Oecophylla*, a beneficial predacious ant, (Photos. 64 and 65, Vol.2) was present on both types of tree.

Cashew can have many advantages in semi-arid regions, both financially and environmentally, 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.

14. **Commercial constraints at the farm-gate**

14.1 **Selling**

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 Diakhabiy (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 3 buyers each offering successively higher prices. Obviously the situation is improving there.

In Sansale region (Guinea) farmers often exchanged cashew for rice; in 1999 1 bag of rice was equivalent to1.5 bags of cashew, in 2000 it had increased to 2 bags of rice = 1 bag of cashew. In Guinea Bissau bartering for rice was a very common practice.

The majority of farmers did not have a problem actually selling their yield. 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, them farmers need to co-operate and bulk their nuts and arrange transport themselves, if possible.

15.2 Prices

Examples of prices paid for cashew over the past couple of years are given throughout Annexes 1 and 2, and generally speaking, the maximum prices paid to farmers were in-line with what could be expected from international prices. However the following problems were apparent:-

1. Price variability during the season with very low prices at the beginning of the season. Those farmers which were short of cash early in the season were forced to sell, often at very low prices.
2. Variation in price between neighbouring villages at the same time of year
3. Farmers lack information on prices and what to expect.
4. 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.

In Kankan region (Guinea) the prevailing price for cashew in 2000 was between GNF 500 and 600, which was much lower than in Boke (Guinea). The reasons were high transport costs either to Conakry (700km) or to Abidjan in Cote d'Ivoire and the GNF / CFA exchange rate. Both Guinean and Ivoirian buyers operated in this area.

According to Mr Traore Vamogognima (Seguela district, Sous-prefecture Masala, Cote d'Ivoire) he was paid between CFA 300 and 330/kg and there was no shortage of buyers. As regards selling, the main problem was the variability in price, in 1997, one buyer offered CFA 40/kg! Buyers also offer different prices at different villages. The farmer did not get any information regarding international cashew prices from the radio or ANADER. For harvesting he pays girls and women CFA 250 to harvest 20 to 25kg of nuts.

The company Olam (based in Singapore), pre-finances Na Mairo & Sons Ltd (a buyer of agricultural commodities based in Lafia, Nigeria), who in turn pre-finance agents to go to villages, buy nuts and bring them back to the warehouse. Last year they used about 100 agents and about 20% absconded with the money. Last year they paid between N22,000 and N50,000 for one ton and bought a total of 1,500 tons. The local buyer gets between 10 and 15% commission. The top price paid by Olam last year was N58,000/ton. Olam collects the nuts and ships them direct to India for processing.

15. Value added products

15.1 Introduction

For all African cashew producing countries, the majority of raw nuts are shipped all the way to India for processing and then re-exportation 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. Obviously there are major benefits to be gained if processing of the nut and the apple can be undertaken in-country, 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 huge taxes are imposed on the export of raw nuts in order to allow local processing industries to compete with India.

Described below are examples of various processing industries in the countries visited.

15.2 Processing of kernels

15.2.1 Guinea.

No processing takes place.

15.2.2 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 Portugal, and the objective is 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.

15.2.3 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 one year at SODIRO training people. The finished kernels were vacuum packed in nitrogen for export and they also produced a smaller packet of ready to eat cashew 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 cashewnuts 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. At the moment it is running at less than one third of capacity and most of the machines (probably 80%) are idle (Photo. 49, Vol.2). The reason for this is that they have not managed to sell the processed kernels since starting in 1998 and have about 4,000 cartons (each 22.68kg) in Abidjan. The factory employs 800 people of which 700 are women. Supply of labour is not a problem. It was not possible to meet the company's managers in Abidjan to obtain more information on this potentially very serious problem, but it urgently needs to be examined in more detail.

The CAJOUCIS cashew processing factory at Korhogo was using both mechanical and hand processing equipment to produce kernels. The mechanical equipment was purchase from Oltremare in Italy and was installed in 1979 with a capacity of approximately 2000 tons of raw nuts per year. The nuts were washed and graded according to thickness. CNSL was used for roasting the raw nuts and as a source of fuel. The nuts were placed manually into holders (clips) prior to mechanical cutting (Photo. 50, Vol.2). A metal blade was used for peeling, which can result in scarification of the kernel. The kernels were simply vacuum packed in 25 lb packs. 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. Presently they are processing 1.5 tonnes per day with this method and hope to reach 2 tonnes per day in the near future. Two shifts operated. Kernel out-turn was given at between 21 to 22%. The amounts processed since 1998/99 are given in Table 12, as can be seen, production is increasing. They hope to process 2,500 tonnes in 2001/2002.

Unfortunately more detailed production statistics, e.g. percentages of each grade, were not available from the factory and had to be obtained from the Head office in Abidjan.

Table 12. Amount of kernels processed at CAJOUCIS cashew processing factory, Korhogo, Cote d'Ivoire. (Copied from Table A1.7, Annex 1)

Year	Total production	Source of kernels
1998/99	1,000 tonnes	Mechanised
1999/00	1,500 tonnes	Mechanised
2000/01	2,000 tonnes	Mechanised + hand
2001/02	(2,500 tonnes)	Mechanised + hand

15.2.4 Ghana

Technoserve has been instrumental in setting up a fledgling cashew processing industry. In 1996 Techoserve organised a processing workshop for farmer groups with a consultant from Nigeria and a resource person from the Natural Resources Institute (UK). In 1997, a business plan was drawn up for a processing plant with a capacity of 30 tonnes of raw nuts/annum and the equipment was installed the same year. The association which 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 but 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 3 processing factories in all, based at:-

1. Msawkaw,
2. Kabile,
3. Sampa

The target for 2001 for the 3 units is 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 (see Photo. 48, Vol.2). The Golden Harvest company is owned by the 3 processing associations (45%) and Ms. Esi, who owns Mase Foods. Again 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 already they have been 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.

15.2.5 Nigeria

At the Premier Cashew Industry Estate (Oghe, Enugu State) was an old cashew processing factory which 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 looking 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 (Photo. 51, Vol.2). 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 9 years of operation.

The Cashew Processing Industries factory (Ibadan, Oya 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 CO_2). The company had introduced Indian type hand shelling machines in 1999 (made in Nigeria), and either one or two people operate one machine. Apparently 2 people can shell up to 60kg of raw nuts in one 8 hour shift.

After shelling the kernel out-turn ratio 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 process, to purchase raw nuts, pay for labour, buy consumables (e.g. gloves), but the bank will not loan any money until a letter of credit has been issued by the prospective purchaser of kernels - and they are finding it difficult to find buyers, especially overseas. Why this should be so was not made clear. They now hope to sell raw nuts from the Cashew Processing Industry Farm at Iwo, Osun State (see above) to finance processing of other people's nuts under contract. It remains to be seen whether this will work or not.

15.2.6 Conclusions

With regard to the processing of nuts, the story is mixed. On the positive side is the initiative in Ghana and the CAJOUCIS factory at Korhogo, Cote d'Ivoire. In the intermediate position is the SODIRO cashew factory at Odienne, Cote 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, Oya 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.

15.3 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. For example see Photos. 52 and 53 (Vol.2). The first shows the family of Mr Fakoly Fofana (Monkono, Cote d'Ivoire) busy separating the nut from the apple of that morning's harvest; unfortunately all the apples were left to rot on the ground. The second shows Mr. Yaya Umoru (Ochaja, Kogi State, Nigeria) and children with the morning's cashew harvest; after bringing the fruits back to the farm house, the nut is detached and the apple is thrown away.

In Lafia state (Nigeria), there was more interest in using the apples: here, apples were sold in the market and by the roadside (see Photos. 54 and 55, Vol.2); there was also interest expressed in processing the apples into juice.

The most remarkable use of apples seen during the survey (and anywhere else in Africa) 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 (see Photos. 56, 57, 58 and 59, Vol.2). 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. The brandy was in the duty free shop at Accra airport and looked as professionally

finished as the more well known brandy and whiskey brands. The plantation sells one bottle for CD 15,000 but this is a promotional price, it will increase to CD 25,000 some time in the future.

From the daily field collection of nuts/apples, only about 35% of the apples are selected for brandy processing. If a delay of only 12 hours occurs, then the percentage of apples wasted goes up significantly. The apples are not picked, they are allowed to completely ripen on the tree and drop, in order to maximise the sugar content. Some of the brandy making equipment was purchased in South Africa and the remainder manufactured locally.

16. Recommendations

Introduction

One of the objectives as stated in the Activity Proposal (Annex 7) is to provide an organisational framework of research and development opportunities for the region. It is anticipated that identified institutes will engage in **collaborative** projects to develop the potential of cashew in West Africa. This will involve relevant research ranging from breeding, crossing and selection to crop protection and on-farm husbandry. In the longer term, this will be integrated with extension activities and social dimensions. In other words, through a participatory process, transfer new technologies and knowledge to smallholder farmers. This in turn should promote sustainable tree crop systems that increase productivity, generate greater income, and protect the environment.

Table 13 provides a summary of research and development (R&D) recommendations: the reasons behind all of these recommendations are discussed in the appropriate sections of the report. Priority is on a scale of 1 to 3 and cost on a scale of low – medium – high.

Table 13. Summary of research and development (R&D) recommendations
Gu - Guinea, C – Cote d'Ivoire, Gh - Ghana, N - Nigeria

Priority	Countries	Objective	Relative cost
1	All	Implement vegetative propagation workshop	Medium
1	All	Implement selection and breeding trials	High
1	Adviser & all	Produce standardised manual of pests, diseases, research methods in English and French	Medium
2	External & all	Review literature of fire prevention and evaluate strategies	Medium
2	All	Collect quantitative data on the economic status of pests and diseases	Medium
2	Gh	Develop appropriate control strategies for pests and diseases.	Medium
1	Gu	Clarify the importance of anthracnose	Low
2	Gh & N	Determine factors responsible for drying of flowers	Low
1	All	Construct database of yield records	Low
2	Gh	Evaluation and enhancement of natural control of insect pests	Medium
3	C	Review economics of high density planting	Low
Admin	All	Establish a network of coordinators	
Admin		Appoint overall adviser and coordinator	
Admin	All	Improve levels of communication	

C	Review support for extension and implement participatory knowledge based pilot extension project	
Gu	Implement programme of training and support for farmer associations	
C & N	Review marketing of kernels	
N	Develop uses of cashew apples	

NB The country/countries listed to undertake the work are the minimum required, obviously if a particular country has the funds and personnel to do additional work, then that will be encouraged.

Table 13 provides a summary of research and development activities that need doing and their priority. However such an extensive list of work to be done will be constrained by lack of scientists, funding and facilities. Section 9.7 provides some suggestions on how to improve the overall facilities for cashew R&D. Selecting which recommendations can actually be undertaken will be a matter of funding and agreement of the executing agencies. Funding by host country governments is currently very limited. In order to maximise benefits for all countries it will be very important that a regional integrated programme of research and development is agreed and that this is funded from multiple sources, eg governments, donors, private organisations, STCP.

Further details on each of the topics listed in Table 13

At this stage, it is not the intention (or even possible) to provide detailed and budgeted proposals for each of the activities.

The 4 countries refer to Guinea, Cote d'Ivoire, Ghana and Nigeria, but if funding for Guinea Bissau can be found, then there is no reason why it can not participate as well.

All methodology, data recording and data analysis should be standardised to facilitate the pooling and integration of data from all countries.

Implement vegetative propagation workshop

An area which 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 are having to use half-sib seeds all the time, which introduces more variability into the trials. With cashew being such a variable crop anyway, this is undesirable.

It is proposed that a vegetative propagation expert conduct a workshop to transfer this technology to two persons from each of the 4 countries as soon as possible.

The chosen location should be the one most convenient for people to get to, perhaps Ghana or Cote d'Ivoire.

Preparatory work will need to be undertaken by the host organisation by preparing large numbers of seedlings at the right growth stage for practice and a small amount of equipment will need to be purchased.

Implement selection and breeding trials
Quantitative evaluation of existing visually good trees should be carried out over a few years and should include, yield, nut weight, kernel weight and tree characteristics. The best trees can be entered into a simply replicated breeders trial. Care should be taken if selecting any tree, which is growing under particularly ideal conditions (see Section 8.4). There are a number of obvious sites in each of the countries where evaluations should take place, for example some of the estates like the MIM estate in Ghana, the SODIRO and Badikaha estates in Cote d'Ivoire, Kosoni farm, Premier Cashew Industry Farms in Nigeria, and the farm of Mr Sidiki Diakile at Saladou in Guinea.

It is proposed that **at least one**, up to date germplasm trial is established in a main cashew growing area of each of the 4 countries.

Selected material should include:-

1. The best **2 clones** from each of the countries (this will mean careful moving of vegetative material between countries in the region), this material will act as standard material in **all** trials
2. Material from overseas, for example, **seed** from (a) one or two lines of Brazilian dwarfs, (b) Tanzanian polyclonal garden and (c) 2 Indian selections. Again, this will be standard in all trials.
3. **Clones** of the best selected trees from within the individual countries (from on farm or on station)

Mixing clones and seed will present some problems but there is no alternative if material from outside the region is to be evaluated.

There should be a **minimum** of 2 replicates, plot size for clones should be at least 4 and for seed, a minimum of 9 (3 by 3) – but note these really far less than optimal and should be increased if resources permit.

The universal complaint was lack of good planting material. Because of this and 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 must have the highest priority. However, the workshop on vegetative propagation is a prerequisite for the breeding programme.

Produce standardised manual of pests, diseases and research methods in English and French

As mentioned above all methodology, data recording and data analysis should be standardised to facilitate the pooling and integration of data from all countries. If the research is standardised across the region and well integrated, the value of the whole will be more than the sum of the individual parts. A standard manual in French and English, covering pest and disease identification, quantitative methodology for evaluating pests, disease, agronomic and breeding parameters, will be of tremendous help. This will need to be regularly updated.

Literature review of fire prevention and evaluation of strategies
Bush fires and the subsequent damage to cashew is one of the major constraints to cashew production. 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. The French and English literature should be thoroughly evaluated and then recommendations from this review should be evaluated on-farm. Obviously ready access to the literature will be an important factor.

After the literature review various strategies need to be evaluated on farm, for example:-

- where tractors are available, cost sharing strategies might be worked out to make fire breaks
- a hand operated petrol rotavator might be useful for making fire breaks
- growing certain crops around the periphery of cashew plots, that either remain green or ones normally grown and that are kept clean of weeds, need to be explored.

Collect quantitative data on the economic status of 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. 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

Develop appropriate control strategies for pests and diseases

Once a good start on the recommendation "Collect quantitative data on the economic status of pests and diseases" has been made, it will be necessary to research appropriate, environmentally friendly, control strategies, in the first instance natural control if possible and then, if necessary, sensible and rational chemical control methods.

Clarification of the importance of anthracnose

Extensive observations made during the survey would suggest that insect pest damage is of much greater significance than disease problems. As regards the effect of diseases on flowering and nut set, they were generally of minor importance, but it should be noted that this might not always be the case. Although only tiny amounts of what might have been fully developed anthracnose were seen, the confusion regarding the leaf disease as shown in Photos. 16, 17, and 18 (Vol.2) needs to be **urgently** clarified.

Determine factors responsible for drying of flowers

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

Construct database of yield records

Finally, more quantitative yield information is required from a representative number of farms (preferably over a number of years) from all the main cashew growing areas, in order to

determine the yield potential and profitability of cashew in the different areas. This would be a matter of identifying a number of representative villages and then selecting a number of farmers, perhaps randomly from a register of cashew farmers, and then collecting only reliable past yield information and monitoring future yield data more thoroughly.

This exercise would not cost much and yet would provide very useful data for developing cashew.

Evaluation and enhancement of natural control of insect pests
A convenient starting point would be an evaluation of the potential beneficial role of the predacious ant *Oecophylla* (see Photos. 64 and 65, Vol 2). In East Africa and elsewhere, *Oecophylla* has been shown to significantly reduce *Helopeltis* (sucking pest) damage. As a result of this, research has been conducted on ways of enhancing the territory of *Oecophylla* . Although not very common on cashew in West Africa, *Oecophylla* was seen in sufficient numbers to warrant research on its potential to reduce damage by Helopeltis and the much larger *Anoplocnemis curvipes.*

Review economics of high density planting
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. A selection of as similar as possible paired plots could be analysed, one plot low-density and the other high-density cashew.

The following 3 recommendations are administrative.

Establish a network of coordinators

In-country coordinators should be formally identified, with clear terms of reference for coordinating the work within their own country and liaising with other countries. The obvious choices for such positions would be those people participating in this survey. Improved levels of communication will be needed.

Appoint overall adviser and coordinator

It will be essential to identify an organisation to provide broad-based advice and practical co-ordination at an early stage. This will be needed to allow the network noted above to have a focus and also to provide the necessary inputs to ensure appropriate levels of help and advice are given. BioHybrids AgriSystems Ltd could provide such a role, with their added advantage of active links with East Africa, but this would need to be viewed by those involved.

Improve levels of communication
Good communication is imperative to the success of the network and at the moment just basic communication need to be improved.

Normally with a crop of national importance there are many players involved, producers, farmer associations, research, extension, buyers, traders, transport companies, processors, exporters, etc and it is important that all these different players “talk” to each other to ensure a reasonable level of co-ordination and vertical integration along what can often be a complex chain. There needs to be appointed by consensus, a manageable group of stakeholders from producers, research, extension, NGOs, traders, processors, government, that can co-ordinate activities within each country. Such a “stakeholder committee” could and should play a pivotal role in organising, co-ordinating and motivating the cashew

industry. Some countries have already had stakeholder meetings, but these should be formalised and meet on a regular basis, at least once a year, preferably twice.

The remaining recommendations are outside the remit of the current survey but are very important and are included for future action.

Review support for extension and implement participatory knowledge based pilot extension project

The extension service for cashew farmers in most parts of all the countries surveyed was either weak, limited in manpower, transport and/or financial resources or non-existent.

Extension is a very important and yet a very difficult and complex subject, especially when dealing with resource poor farmers that are often numerous and widely spread. An extension focused review would be desirable.

In the mean time it would be of benefit to start a participatory, knowledge-based, pilot extension project, testing alternative approaches, for example:-

4. A knowledge-based approach to extension has many benefits over simple impact points, this builds upon existing farmer knowledge 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.
5. Work with farmer groups and farmer associations which can act as focal points for extension activities
6. Train farmers to act as extensionists (with regular supervision to ensure that they are not making mistakes and passing this on to others).

Implement programme of training and support for farmer associations

Farmer associations, in one form or another were met in all countries visited and most were receiving no support at all. 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. Training was a constant request from nearly all farmer associations, including the larger ones as for example found in Cote d'Ivoire. It is vital that training is provided as soon as possible, especially for the smaller, new, farmer-generated 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 strong 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.

The priority country for farmer associations should be Guinea.

Review of marketing of kernels

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. Without the ability to market the end product, then obviously the whole processing industry will collapse

and the potential for value-added will be lost. Also, if some factories experience such marketing problems, this could also reduce confidence in other factories.

The priority countries should be Cote d'Ivoire and Nigeria

Develop uses of cashew apples

In all countries visited, the vast majority of cashew apples, which are nutritious and high in vitamin C, are simply wasted. More work on this valuable resource should be undertaken. CRIN in Nigeria has undertaken some work in this area and perhaps would be suited to develop suitable apple processing equipment and start distributing to farmer groups. The establishment of small-scale juice processing plants can add value to the product and create employment at many levels.

Training

All of the above activities will rely crucially on having trained personnel at all levels. The type and needs for training are varied and cannot be easily specified in any simple way in this report. Some aspects have been specified, such as skills in vegetative propagation, in extension, etc. and some of these will require more than simple "field skills and training".

Also, there is a need to increase the higher levels of the knowledge base in order to allow the development of suitable background information to ensure "knowledge based" decision, planning and exploitation potentials, in other words to ensure that decisions are based on sound scientific and practical information. Therefore, in addition to the training specifically identified, a well-considered programme of PhD, Masters and Bachelor training needs to be implemented. But before that is implemented an assessment must be made of what is currently available over **all** this region (but necessarily presently identified as for cashew) and a mechanism implemented to allow the efficient sharing of knowledge and resources.

However the primary and urgent need is to make full use of the knowledge already available within the region but which is in "isolated pockets" – the use of "hands-on" training, workshops and strategy meetings will need to be an early feature of the network and one which will bring tangible results in a realistic time scale. See also the other sections particularly on Farmer Associations.

17. Summary – See Executive Summary

If such a networking arrangement as envisaged above can become reality, then each country will become more aware of the status of the crop and activities related to it in other countries within the region, thereby allowing research workers to share ideas, new technologies, knowledge and problems. The opportunities for regional cross-cutting, problem solving will be significantly enhanced and any duplication of effort minimised. It will provide the basic underlying data and information on which research, development and extension activities for cashew can be based in the future.

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