PrOpCom

Making Nigerian Agricultural Markets Work for the Poor

Monograph Series # 8

REVIEW OF THE BIRD PEST PROBLEM AND BIRD SCARING IN SOUTH WEST NIGERIA

By

CLIVE ELLIOTT
And
EPHRAIM BRIGHT
(Consultants)

February 2007

DFID Department for International Development

Funding for this programme is provided by the United Kingdom's Department for International Development (DFID)

40 Mississippi Street, Maitama, Abuja, Nigeria • Tel: +(234) 9 413 8291/2 • Fax: +(234) 9 413 829

Disclaimer

The PrOpCom Monograph Series seeks to provide a broader dissemination of the information and views collected through the efforts of the various service providers and consultants undertaking work in support of the PrOpCom programme. We believe this information will be useful in informing the policy dialogue in Nigeria and for improving the planning and execution of agricultural and agribusiness activities within the country.

The documents in this series represent the final deliverables as presented by the engaged service providers or consultants in responds to terms of reference of contracts let by PrOpCom in execution of its programme. They have not been further edited or editorially polished. Consequently, there is wide variation in the editorial quality of these documents. Nevertheless, the information contained in these document is deems useful for policy and planning purposes.

The views and opinions expressed in these documents are solely those of the authors of the document and do not necessarily represent the views of PrOpCom, SAII Associates, Chemonics International or PrOpCom's funding agent, the Government of the United Kingdom's Department for International Development (DFID)

Information from these documents can be freely used and quoted on condition that it is properly sourced to the concerned document.

REVIEW OF THE BIRD PEST PROBLEM

AND BIRD SCARING

IN SOUTH WEST NIGERIA

by

CLIVE ELLIOTT and EPHRAIM BRIGHT (Consultants)

Prepared for the:
Promoting Pro-Poor Opportunities through Commodity and Service Markets (PrOpCom) Programme

Under the contract awarded to:
SAII Associates Ltd/Gte (Chemonics International Inc.);
Funded by the Department for International Development (DFID), UK.

Abuja, Nigeria

February 2007

EXECUTIVE SUMMARY

The PrOpCom Programme to improve the livelihoods of poor people in Nigeria is focusing initially on rice as a primary commodity. It was reported that farmers perceived birds as the major constraint in rice production, that up to 75% of total output could be consumed by birds and that up to 50% of production costs went into bird scaring. It was decided to hire one international and one national consultant to investigate the matter and to make recommendations for the best approach to addressing the bird pest problem. The consultants were expected to review methods used elsewhere in the world to prevent or reduce bird damage to crops, and to collect information on those currently employed by farmers in the Ofada rice producing areas in South West Nigeria. A first visit consultancy was organized from 28 January to 11 February, which would report its findings to a stakeholders meeting to be held in early March. After the meeting, follow up action during the 2007 rice-growing season would be agreed upon.

The consultants completed a review of techniques used to combat bird pest problems around the world. It was noted that birds not only cause damage to agriculture but can also create difficulties at airports and in urban areas. Pest birds adversely affect food production, human health, safety and the ambiance of people's homes. Many different approaches have been tried to scare birds away, to kill them or to try to make the places they visit less attractive to them. Unfortunately none of the methods available offers a panacea that solves the problem. In Europe and North America, monoculture cropping over thousands of hectares, in which very little natural vegetation remains, may be unattractive to birds or may dilute their effects on production. Farmers may be able to ignore small losses or build them into the cost of production. Where farms are smaller, the bird pest problem has to be examined in detail before a management strategy can be developed. Because birds are highly visible, they may be blamed for production losses that are mainly due to other causes. The whole crop production cycle needs to be analyzed to put bird damage into the context of other factors contributing to low yields such as poor seed quality, poor soils, insufficient fertilizer, lack of weeding, late harvesting, and losses caused by plant diseases, insects and rodents. If the conclusion is that the birds are genuinely a serious constraint, then the species involved must be identified and its biology understood.

Certain principles need to be understood in developing a management strategy for bird damage avoidance. One is that if a bird species is numerous enough to cause serious crop damage, it is likely to be impossible to eradicate the species or to reduce its numbers to the point at which it causes insignificant damage. Bird numbers are generally limited by the availability of natural food, for which they compete with each other to survive. If a proportion of the birds is killed, it makes it easier for the others to survive. Lethal control of a pest bird has never provided more than a temporary or localized solution. Another principle is that bird scaring devices that are not accompanied by a threat to the life of a bird or a risk that it be injured, cease to function after a few days because the birds become used to them. Chemicals that repel birds have been developed but they do not always work, and are used regularly only rarely in world agriculture for treating fruit and as a seed dressing to discourage birds from pulling the seeds up after planting. Sometimes if a farmer substitutes one crop which is vulnerable to birds, with one that is not, he may solve the problem. Attempts to grow varieties of crops that are less preferred by birds have not been a success as either they are less preferred by people, or the birds learn how to eat the new variety.

Changing the planting date to avoid peak populations of pest birds can provide a partial solution.

In Sub-Saharan Africa, most of the work on pest birds has concentrated on the Red-billed Quelea *Quelea quelea* which is the most numerous and can sometimes occur in flocks of hundreds of thousands. It is a pest of savannah areas and can devastate small grain crops (sorghum, millet, wheat and rice). Large-scale lethal control is still practiced in at least 11 countries in Africa, mainly employing aerial spraying of an organophosphate poison, fenthion. Sometimes explosives are used with barrels of fuel to create a firebomb effect. In recent years, research has shown that aerial spraying has a more insidious effect on the environment than was first thought, with drift of the spray cloud and secondary effects on birds of prey over a much larger area than the original target. Aerial spraying is also expensive and potentially dangerous for the pilot. As a result, some countries such as South Africa are making greater use of firebombs that are environmentally cleaner, but in general, there is an earnest search for alternatives to aerial spraying. These include trapping techniques that allow the birds to be used as uncontaminated food.

Bird scaring is traditionally used all over Africa, employing shouts, other forms of noise, missiles hurled at the birds, and ropes with rattling cans strung across the fields. Wherever it is, the bird scarer’s job is an arduous one, requiring him/her to be in the fields from first light until dusk during the whole ripening period. Late arrival of the scarer will allow the birds to cause substantial damage as they feed intensively in the first hours of daylight. Studies have shown that there is a direct correlation between the efficacy of scaring and the degree of ownership of the farm. If a farmer is guarding his own field, he is the most efficient. If he gives the task to his children, they will be less efficient. If he hires labourers as scarers, they will be the least efficient unless he supervises them closely, which means that he too has to be in the fields all day. A strongly motivated and well-equipped person (noise-making cans, tins or drums, catapults or slings, ropes across the field) should be able to scare birds successfully from about one hectare of crops. Many devices that have been used in Europe and America for scaring birds have been tried in Africa, but they all suffer from the same problem. After a few days, the birds get used to them and are less and less scared.

Elsewhere in Africa, chemical repellents have been tried but with mixed success, and they have up to now never become routinely used. Much research has been carried out on trying to breed varieties of crops that birds do not like. The varieties may have a high tannin content (sorghum), an odd shaped panicle (sorghum), or they may have long awns (rice and millet). Unfortunately, high tannin cereals are also less preferred by people, as well as by the birds. If offered a choice between awnless and awned rice, birds prefer the awnless, but if they have no choice, they will eat the awned variety. Early planting of rice has been shown to be effective in avoiding pest birds, for example in Cameroon and Chad, but is applicable mainly to irrigated crops where the planting date is easy to manipulate. Good weeding and clean surroundings to fields have also been shown to reduce the attractiveness of cereals, including wheat and rice. Different sorts of netting have been shown to be effective in keeping birds out of crops, but their usefulness depends on their cost and how many times they can be re-used. Tapes and threads stretched across the fields have been shown to be useful in some circumstances, but sometimes the birds get used to them and ignore them.

The consultants were not able to make direct observations of the bird pest problem in Ofada rice because the visit coincided with the dry season when no crops were in the fields. Instead information was collected from discussions with officials at the Federal and State levels, and with farmers and their representatives at RIFANs and in their fields. The Government's policy at the Federal level was to take responsibility for transboundary bird pests (only quelea), but it was expected that for other bird pests, the responsibility would be with the farmers and the states. Visits were made to Ogun, Osun and Ekiti states. The consensus in all the states was that the birds were the most important constraint to rice production. In many cases, farmers had decided to give up rice farming after they had suffered serious damage to their crops. The consultants could not verify the bird species involved, but the descriptions suggested that the main culprits were Village Weavers, Red-headed Quelea, and Bronze Mannikins. Bird scaring followed the typical African pattern but there were local variations. Most of it appeared to be done by hired labourers, mainly secondary school children during their holidays, who were under the supervision of the farmer. The amount paid ranged from ₦ 133-500/person/day with ₦ 500 being most frequently mentioned. The duration of scaring was 30-35 days, with most farmers using two scarers per hectare, but some only one. The cost of bird scaring was therefore about ₦30,000 – 35,000/ha. Most farmers felt that with good bird scaring they could keep losses to about 20%. With no scaring, the losses would reach 90-100%.

In most of the farms visited, mention was made of using juju to protect fields. The juju is obtained from a traditional medicine man. Some of it is buried in the field and some is fixed on sticks at the four corners of the field. The juju apparently only works if various conditions are met, some of them involving women. Most of the farmers thought it used to work in the old days when the bird pressure was lower, but did not work anymore, being replaced in modern times by bird scaring. A few farmers were convinced it worked well, and said their fields never needed any scaring. None of the farmers could explain adequately how it might work. At UNAAB, some observation of juju had been made but no experimental work on juju had been done in controlled conditions such as cage trials.
At WARDA, it was reported that rice trial plots extending to a hectare had been satisfactorily protected with enclosure netting imported from the Philppines. The net was still usable 10 years later.

Based on the information collected, the consultants drew the following conclusions:-

- Bird damage to Ofada rice is perceived by farmers to be the major constraint. The collection of objective/empirical data on damage levels could be carried out if this is considered to be a priority. The consultants or others could provide training. The work is laborious and time consuming. If statistically valid samples are required, one vehicle and a team of four would need to be allocated to each state for the duration of the harvesting period. Damage estimates are normally made just before harvest.
- The ecology/biology of bird damage in South West Nigeria suggests that the pest birds are unlikely to present good targets for lethal control as they are too dispersed for aerial spraying or firebombs. Lethal control is not an option except for farmers to attack the breeding colonies of the weavers, which might make the birds move further away from the rice fields.
- Bird scaring techniques could be improved at least marginally. An Integrated Pest Management approach, working with farmers to make their fields as unattractive to birds as possible would be an important approach towards reducing the damage; early planting, good weeding, clean surrounds, better scaring, quick harvesting, would all contribute. The consultants recommended the inclusion of IPM training.
- Ribbons and threads could be tested, as they do not cost much, but it is likely that pest birds will habituate to them.

- The review of international methods used for bird control suggested to the consultants that using complete enclosure netting might be the best option, depending on the cost. Information from farmers and from WARDA suggested that if similar netting to that WARDA had used, was employed, farmers would break-even, if they obtained a yield of 1.4 tonnes/ha. A Spread Sheet was prepared in which figures may be changed according to local circumstances and prices. Since PrOpCom is attempting to increase yields and the current yield range reported to the consultants was 0.8 – 1.5 t/ha for Ofada rice, the capacity to make the nets cost-effective seems to exist. The consultants recommended that field trials of one hectare of netting in each target state should be implemented in the forthcoming rice season. Positive results could lead to negotiation for the lowest possible price for the netting and extensive use by farmers. Netting remains the only technique that is 100% effective, provided the net does not get torn or damaged.

1. INTRODUCTION

The PrOpCom Programme seeks to improve livelihoods in Nigeria by facilitating growth and pro-poor outcomes in commodity and service markets and addressing the systemic reasons that prevent these markets from functioning effectively for the poor. Initially PrOpCom is focusing on rice as the primary commodity. In South West Nigeria, bird pests have been identified as a major constraint on rice production. Birds are reported to have eaten up to 75% of total output from entire production areas. To combat the birds, farmers are often obliged to hire bird scarers and in one state (Ogun), the costs of bird scarers is reported to account for as much as 50% of production costs. In some areas in South West Nigeria, miller-marketers have not been able to sustain their operations, leaving farmers with limited choices for selling their harvests.

In addressing the problem of birds in rice production, PrOpCom recognizes that there are few practical means available for preventing the impact. Nevertheless, it was considered important to review the recommendations that have been made in the past by committees, task forces and special agencies of local, state, and federal governments, and to identify those that have worked. PrOpCom also wished to review methods that have proven successful outside Nigeria.

To carry out these tasks, PrOpCom recruited a local and an international consultant. It was expected that the work would be carried out in two stages. The first was scheduled for January/February 2007 and was expected to focus on the state of the art approaches to bird scaring and international best practices in weaver bird control. The second was expected to take place during the harvest season and to gather empirical evidence of the impact of weaver birds on rice production and of various bird scaring techniques.

This report describes the results obtained during the first stage of the investigation. It was expected to include the following sections:-

- A detailed review of available data on the bird problem and bird scaring techniques in South West Nigeria, and an assessment of the quality of the data;
- A review of bird damage prevention outside Nigeria;
- A review of scientific and “traditional” techniques used for bird scaring in Ofada rice production areas, and farmers’ perceptions of those that they have tried.
- Recommendations for the best approaches to bird scaring or damage prevention, and what steps should be taken to implement them;
- A list of names and contact information of key informants and farmers who have experience with different bird scaring techniques.

2. METHODS

The timing of the first stage of the consultancy to the period 28 January to 12 February 2007 meant that no rice was growing in the field and that no direct observation could be made of the impact of birds on the rice crop, nor of the scaring techniques that were used. Instead the opportunity was taken to talk to state and federal officials who could be identified as being concerned with rice production and/or with bird control, and to a sample of farmers and their representatives in the three Ofada rice producing states of Ogun, Osun and Ekiti. Several fields used for rice cultivation were inspected so that the ecological setting could be appreciated. A visit was also made to the Africa Rice Center (WARDA) office for Nigeria at the International Institute for Tropical Agriculture (IITA) at Ibadan, and to the University of Agriculture at Abeokuta. A list of those met and their contact details is given as Annex 1.

3. RESULTS

3.1. Background on the bird pest problem:

Bird pests are a global problem for agriculture (De Grazio 1989). They also impact on other areas of human activity including airports where they can be a danger to aircraft and urban situations where they may contaminate public areas or water supplies or cause various other nuisances (Thearle 1968). As a result of the significant economic losses that birds cause, directly or indirectly, not only to agriculture but also in these many other ways, enormous resources have been devoted over the years to finding ways to alleviate the problems. The reason why the birds gather in places where they cause damage to crops or create a danger for human safety or health are usually obvious. If it is a crop that is affected, then the birds are seeking easy food, whether it is fruit, grain or seeds. If they are around airports, it is because the airports offer wide open spaces that provide food or a safe place to rest where an approaching predator can be seen well in advance. If they are roosting in urban areas, they are finding it warmer, more protected from the wind and usually predator-free. Dealing with this great variety of situations requires understanding of why the birds are there in the first place, and then trying to remove this reason or at least making it less attractive

In Europe, North and South America, South East Asia and the Antipodes, various forms of bird impact on agriculture occur. Despite the research effort, no global panacea has been produced. The nearest to a panacea that has been reached is the mass-production of a **monoculture cropping.** When the area grown runs to thousands or tens of thousands of hectares, with very little natural vegetation left, the environment usually becomes unattractive to pest birds or any damage they do is only a small percentage (<5%) of the available crop. The farmer can tolerate this loss and build it into his cost of production. Monoculture cropping applies only to agriculture in certain parts of the world, particularly Europe and North America where an added factor is that the pest birds do not achieve the very high numbers found in Africa. It is not typical of the vast majority of farms that are mostly much smaller. There the birds can make a significant impact on crop production. Research has shown that every situation has to be examined in detail on its own merits. The development of a management strategy for the birds which will reduce the impact to an acceptable level can be a difficult task. Experience has shown that it is important to assess the problem objectively because farmers may blame birds because they are so visible, when in reality they may be only a contributory factor to low yields. An analysis of the whole production cycle may show that low yields are in part due to inappropriate seed varieties, poor seed quality, poor soils, insufficient use of fertilizer, lack of weeding, late harvesting causing shattering, and losses caused by plant diseases, insects, and by rodents that feed on the crop unobserved during the night. On the other hand, an objective analysis may show that the bird damage problem is a serious one, although it is often patchy in its distribution with certain areas badly affected and others not far away that have not been touched. An objective assessment of the average level of damage and of the total loss caused in a major area, state, or even in a country as a whole, helps to indicate the importance of the problem and what level of resources should be devoted to finding a solution. Of course, the species of bird involved needs to be identified. There may be several, working in consort. Having identified them, it is necessary to understand their biology. Are the birds attacking the crop during their breeding season in which case they will be moving forwards and backwards from their breeding colonies? Or do the attacks come mainly after the breeding season, in which case they will be coming from roosts and most of them may be young birds? Or are they migrants that move in from somewhere else? If the damage is more severe for early or late planted crops, is there some aspect of the biology of the bird that causes this difference.

If a study of the biology of a bird pest suggests a solution, then such solutions have to be tested out in various circumstances, to determine what the limitations of the solution are. Outside agriculture, the example of birds at airports provides some clues to how a solution evolves. The problem was identified as serious as the ingestion of a bird into a jet engine could put it out of action, at best sometimes costing hundreds of thousands of dollars in repair bills, and at worst causing a fatal crash (Stables and New 1968). Many different methods were used to try to scare birds away from airports. Distress calls of birds were broadcast over loudspeakers, and people toured the airport perimeters and shot at the birds with shotguns. Trained falcons were flown at the birds to chase them away. None of these worked well except for the falcons, which were very expensive to employ. The other scaring devices tended to work well but only for a few days until the birds got used to the disturbance and learned how to avoid them. Finally research concentrated on trying to work out why the birds liked the airports in the first place. Sometimes they found that, near the airport, there was a large rubbish dump that attracted the birds in the first place. The airport was a convenient place to rest after they had fed. Or they found that with the grass kept short, airports were convenient places to search for insects, worms, or clover. The solutions that worked best were to relocate rubbish dumps far away from the airport, to cut the grass on the airport to a height of about 40-50cm so that it was no longer easy for the birds to walk around, or to use selective herbicides that killed the clover that some birds liked to eat (Wright 1968). This made the habitat no longer convenient for resting or for feeding.

For agriculture, the reason the birds attack the crop is clear. They are seeking food. In most cases, farmers do not grow sufficiently large expanses of crop to dilute the losses to the point at which they can be ignored. Instead they seek solutions to the problem. Many different techniques have been developed and these are reviewed below:-

3.2. <u>Global solutions to bird pests of agriculture</u>:

3.2.1. Lethal control outside Sub-Saharan Africa:

The natural reaction of most farmers to birds eating his crop is to try to kill the bird. In a few cultures such as Buddhism, this tendency has been overridden by a belief that all creatures have a right to life, even those that may cause hardship to humans. In those where killing is permissible, the objective may be not only to kill the bird that is attacking the crop, but to extend this to an attempt to eradicate the pest species altogether. Bird species that are pests are, by definition, numerous. Research has shown that their population levels are in equilibrium with their natural food supplies. The individual birds compete for the available food and the fittest survive and leave the most offspring. In most cases it is the availability of the natural food that determines the bird population size. If an artificial source of food is added to the natural food, only rarely does this enable the birds to reach higher populations than normal, as natural bottlenecks in the annual cycle remain.

The smaller the bird, the shorter is its life span. Most small birds have an average life span of about two or three years. So there is a big turnover, especially among young birds in their first year of life. Many of them fail to make it to adulthood because they are inefficient at finding enough food and are inexperienced at avoiding predators. If the pest bird population is killed in big numbers, it makes it easier for the others to survive. Attempts to eradicate pest species or to reduce their populations to levels at which they are no longer numerous enough to cause damage have not worked. In Great Britain, the Wood Pigeon *Columba palumbus* caused serious damage to *brassica* crops (Murton *et al.* 1966). In an attempt to reduce numbers to non-pest levels, a bounty was paid to hunters for each pigeon killed. After much expenditure, no noticeable reduction in Wood Pigeon numbers was recorded. The Indian House Crow *Corvus splendens* invaded the eastern shores of Africa from its native habitat in the Indian Subcontinent and caused a lot of damage to indigenous songbirds and the tourist industry. Attempts to eradicate the bird with trapping, poisoning, and offering a bounty for all eggs collected from crow nests, caused only temporary drops in population (Archer 1995). The reason was that the crows were subsisting on urban rubbish, and as long as there was plenty of rubbish, they could quickly breed up and replace those birds that had been killed. The solution most likely to succeed would be to collect the rubbish in closed containers and process it in such a way that the crows cannot feed on it.

These two examples illustrate the principle that, in almost all circumstances, lethal control to reduce bird pest populations to non-pest levels does not work.
By contrast, lethal control to reduce pest bird numbers in the vicinity of crops has been used successfully in a number of countries. The methods used include various forms of trap, shooting, destruction of nests, explosives by themselves or in combination with other substances, and aerial spraying of chemicals or poisons (reference). In the present day, **traps** are used to control Bullfinches *Pyrrhula pyrrhula* in Great Britain to reduce the damage they do to the buds of fruit trees (Newton 1968). The traps are placed in woodlands around the orchards in autumn and in the orchards themselves in spring. A live bullfinch is placed inside the trap to act as a decoy and attract the others in. The method can reduce the local bullfinch population for long enough for the fruit to develop past the bud stage. Traps are also used in Tunisia to catch European Starlings *Sturnus vulgaris* that are damaging the olive crop. The trap is a large netting funnel, the mouth of which is a semi-circle 8m high and 25m across (Elliott, pers.obs.). Several thousand starlings are caught in one operation. They are sold locally as food and some are exported. The available data does not indicate if the trapping significantly reduces the amount of damage to the olives. **Shooting** was mentioned in the context of the Wood Pigeon. It has also been used to control Eared Doves *Zenaida auriculata*, but, even though thousands of birds have been shot, the impact of the shooting is minimal except in highly localized areas (Bucher and Ranvaud 2006). **Nest destruction** is used in Tunisia for the control of the Spanish Sparrow *Passer hispaniola* which causes damage to wheat (Bortoli 1969). Local people equipped with long poles pull the nests out of tall eucalyptus trees, when the nests contain eggs or chicks. This causes a colony of sparrows to abandon the local area allowing wheat in the vicinity to mature without damage. The sparrows

may try to breed again but in a different habitat. **Explosions** are used in northern Europe, particularly in Belgium and France to control European Starlings that are attacking cherries (Tahon 1980). The starlings roost in concentrations of hundreds of thousands and this offers a target for the control teams. It is reported that following a successful explosion, cherry damage stops in the vicinity for some days, but new populations may move in later and the damage can restart. Explosives under piles of small stones are used to control sparrows and starlings in Tunisia (Buraoui, pers.comm.). When the explosive is set off, the stones act like shrapnel and large numbers of birds are killed. The technique brings benefits to crops grown locally, but replacement populations of pest birds may move in later. **Aerial spraying of surfactants** or soapy materials that destroy the insulation properties of birds' feathers has been tried in the United States to control blackbird and starling roosts in winter (Lefebvre and Seubert 1970). It can only be used when the nights are near freezing, and the birds die of cold. **Aerial spraying of poisons** has been used in Morocco for controlling sparrows and starlings (Hafraoui pers. comm). Although the results were good, the practice was stopped because of concerns for the environment.

In recent years, concern about the environment has become stronger and lethal control is rarely used outside the African continent. The main reasons for this change of heart is that lethal methods tend to be indiscriminate, killing all the birds in the target zone whether they are pests or not, and the relationship between the number of birds killed and a reduction in the damage to crops is often unclear. Furthermore, as people become more conservation-conscious and bird watching becomes increasingly popular as a tourist activity, pressure is placed on governments to seek alternatives to lethal control.

3.2.2. Non-lethal control outside Sub-Saharan Africa:

An extensive research effort has gone into efforts to scare birds out of the fields where they are causing damage. The variety of devices is enormous. However, the research has revealed the basic principle that if **scaring devices** are used which are visual or acoustic, but which do not offer any threat to the birds' lives, then, after usually a few days, the birds become habituated to the scaring device and begin to ignore it (Inglis, I.R. 1980, Slater 1980). A technique that has been often used in North America and Europe is the carbide cannon, which produces a loud bang. Various sophistications exist to make the bang irregular and to change the angle of the cannon so that the bang is not always coming from the same direction. These may delay the habituation by a day or two. If the carbide cannon is accompanied by several people walking around a farm with shotguns and shooting at the pest birds, they work much better, but the cost of manpower is usually prohibitive. Many other devices are on the market; scarecrows that pop up in fields and wave their arms, scaring strings with flags that are moved by a machine at irregular intervals, helium-filled balloons of various designs, some with large eyes painted on them, that float above the crop, other noise-producing devices that project high-pitched sound inaudible to humans but audible to birds. Some farmers in Europe have tried to overcome the problem of habituation by switching from one type of scaring device to another every few days. This improves the effect but requires a high investment in the different devices and a close management of the systems to know when to switch from one to the other. The principle remains the same, that eventually habituation will set in and the pest birds will ignore the scaring device.

A number of chemicals have been developed that act as **bird repellents** (Wright 1980). Sometimes the repellent is applied to seeds to discourage birds from pulling them out of the ground when they are planted and sometimes they are applied to the ripening grain itself. They function in variety of ways; tactile (chemical modification of the grain surface), taste (chemical modification of flavour), physiological (chemical-induced illness resulting in aversion), and behavioural (causing changes in behaviour of the bird which eats the treated grain such that it frightens the others) (Schafer 1981). Repellents that have been developed include *Curb* (synergized ammonium sulphate), *Mesurol* (methylcarbamate) and *Trimethacarb* (mainly trimethylphenyl methylcarbamate). The chemicals are relatively expensive (>US$ 900/ha) and their efficacy is good when used as a seed dressing, but it is variable when applied to the ripening crop. Both Curb and Mesurol are used regularly as seed dressing, to protect fruit buds, and sometimes to protect cherries in North America, but they have not been exploited to protect grain.

In some cases, farmers have been able to solve their bird pest problems by using **agronomic approaches**, i.e. changing the way in which they grow their crops, or by deciding to change the crop altogether from one which is vulnerable to birds, to one which is not affected by birds. For example, in Great Britain, starlings used to cause extensive damage to freshly drilled winter wheat, pulling the grain out of the ground. Farmers found that by increasing the depth of the drilling, they could place the seed out of reach of the beak of the starling. This resolved the problem caused by the starlings but could expose the seed to attack from the Wheat Bulb Fly (Feare 1984). Some varieties of fruit are damaged more heavily by birds than others. For example Bullfinches prefer the buds of dessert apples to those of cooking apples (Newton 1972). Theoretically a change to the less preferred variety would reduce the damage, but if the less preferred variety is also less preferred by the human consumer this will undermine the price that the farmer obtains for his produce. Also if the bird pest has no choice, it will also eat the less preferred variety.

For farmers growing high value crops such as apples, pears, cherries and grapes, it is becoming more and more common for farmers to install **nets** that completely enclose the crop. Bird damage may only involve a peck or two into the individual fruit or the bunch, but the crop is then unmarketable because consumers will only buy unblemished produce. The nets may be a permanent installation or they may be put up only when the fruit is beginning to ripen and to become vulnerable to birds. The nets prevent the birds from accessing the crop and damage is reduced to zero. In many cases farmers have replaced their old tall fruit trees with dwarf varieties that are easier to enclose in netting. A similar technique is used in parts of Asia, such as the Philippines, where farmers net in their rice paddies to protect them from the White-rumped Munia *Lonchura striata* and the Black-headed Munia *L.malacca*. The technique is used only where the bird pressure on the rice is particularly intense.

3.2.3. Lethal Control in Sub-Saharan Africa, outside Nigeria:

For African agriculture, bird pests have probably existed since cultivation began. An early mention of damage to crops dates to 1881. That birds eat grain crops is not surprising given that most of the grain being cultivated is developed from wild grasses, the seeds of which are part of the birds' natural diet. Research on bird pests in

Africa began in earnest during the Second World War when attempts were made to expand grain cultivation in order to help feed the troops. The main species of bird involved in the sub-region is the Red-billed Quelea *Quelea quelea* (Elliott 1989). It is a pest in savannah country all across Sahelian Africa from Senegal and Mauritania to the Sudan, and south to South Africa. It does not cause problems in forested areas. The Red-billed Quelea, referred to here as the quelea, attacks all the small grain crops including rice, wheat, sorghum and millet. The quelea is probably the most numerous bird in the world, with a population estimated at 1,500 million. The sheer weight of its numbers makes it the most serious bird pest in Sub-Saharan Africa and this status has resulted in its being the most intensively researched bird in Africa. The quelea, being a highly gregarious bird, tends to breed in dense colonies of tens, sometimes hundreds, of hectares, each hectare holding at least 30,000 nests. It also often roosts in dense masses in acacia thickets or reed-beds, and a single roost can contain hundreds of thousands of birds, sometimes more than a million. This behaviour provides good targets for control.

Initial attempts to control the quelea used techniques that were taken from the War, like **explosives** to destroy the breeding colonies or to blow up the roosts where the birds sleep, or **flame-throwers** to burn the nests. **Poison baits** were also used and sometimes poison was put in waterholes where the birds came to drink. Gradually the use of poisons evolved, first by **spraying poisons on crops** such as the highly toxic organophosphate parathion using tractor-borne equipment, then eventually into spraying the poisons by aircraft. In the 1960s and 1970s, the technology of **aerial spraying of poisons** improved, and it became the standard practice in most of the quelea-affected countries (Meinzingen *et al.* 1989). Hundreds of millions of quelea were killed annually and practitioners supposed that the quelea problem would soon be solved. Population reduction was claimed (GTZ 1987), but somehow the quelea population always bounced back especially when good rains fell. In hindsight, it becomes clear that when quelea numbers dropped, it was more because drought was reducing breeding, rather than that control operations were having a major impact. With its ability to move with the rain front and breed again, survivors of quelea control operations could quickly replace the birds that had been killed, provided rains were good. Control operators tended to blame neighbouring countries, claiming that they had controlled all the quelea at home, but inefficiency in the neighbouring country allowed re-invasion. Aerial spraying nevertheless became highly efficient, and the amount of pesticide required to control a colony or roost was reduced to 1-10 litres per hectare, depending on the target, usually using the organophosphate fenthion (queletox), which was less toxic to humans than parathion. The technique was, however, expensive requiring a special spray aircraft, a highly skilled pilot willing and able to fly just above tree level, and a pesticide that cost US$ 10-20 per litre. The technique was also dangerous, and more than one pilot has died during an operation and several non-fatal crashes have occurred. In several countries, the cost of the pesticide was met by gifts from donors, especially under the KR2 (Kennedy Round 2) programme financed by Japan.

Research continued in the 1980s and 1990s and began to show that the **environmental side-effects of aerial spraying** were more insidious than had first been thought. It was known that any bird in the target area would be killed regardless if it was a pest or not. In some circumstances substantial numbers of non-target birds would be killed. The studies showed that the pesticide cloud sprayed over the target drifted several kilometers down wind causing contamination. Furthermore some of the quelea in the target area received a sub-lethal dose and the following morning could fly out into the surrounding area up to about 30 km. These birds would be somewhat sick because of the poison, would fly less well, and be a magnet for non-target birds of prey. These hawks, falcons and eagles might eat several sick quelea and then become poisoned themselves (van der Walt *et al.*). Fenthion was also found to be toxic to fish which would be killed if the spray cloud contaminated a water body.

Aerial spraying continues to be practised in Mauritania, Senegal, Niger, Sudan, Ethiopia, Eritrea, Kenya, Tanzania, Zimbabwe, Namibia and South Africa. Several of these countries are under pressure from environmentalists to reduce aerial spraying. In South Africa, explosives combined with barrels of fuel, to produce a firebomb effect, is used now for almost half of the targets because they cause less environmental side effects, even though fire-bombs cost more than aerial spraying. Firebombs are also regularly used in Kenya, but in other countries security considerations do not allow their use. Economic reasons have also undermined countries' ability to use aerial spraying. Under environmental pressure at home, Japan decided to abolish its provision of free supplies of fenthion to Africa under the KR2 agreement. Many African countries are now searching for alternatives to aerial spraying.

The use of poison bait and the poisoning of waterholes have been stopped in almost every country because of its danger to people, to their livestock and poultry, and to wildlife. Trapping birds to use them for food remains quite common. In Chad, for example, one tribe specializes in catching quelea in dry-season roosts. A three-man team can catch about 1,000 birds in one night. The birds are plucked and partially cooked to preserve them and are sold on the market in N'Djamena. According to one report, up to about 5 million are sold on the market in one year (Mullié 2000). Other sorts of traps are found in many countries but most of them catch only a few birds at a time. None of them, including the Chadian variety, appear to make any significant impact on the quelea population or on reducing damage. For quelea, villagers in many parts of Africa raid the breeding colonies once the chicks are well-grown in the nest and harvest them. Poles with hooks on them are used to pull the nests out of the trees, and hundreds of kilos of chicks can be collected (Elliott pers.obs.). These are de-gutted, dried in the sun, and are used as a rich source of protein food for several weeks.

For most of the other major bird pests in Africa, such as the Red-headed Quelea *Quelea erythrops* and the Village Weaver *Ploceus cucullatus*, the techniques of aerial spraying and explosions are not applicable. The Red-headed Quelea has sometimes been controlled with aerial spraying in Tanzania when it forms large colonies, some of which may be mixed with Red-billed Quelea, but in other parts of its range, aerial spraying has not been used. With the Village Weaver, its colonies and roosts are much more dispersed and do not offer a good target.

3.2.4. Non-lethal control in Sub-Saharan Africa, outside Nigeria:

Bird scaring is the traditional method that is employed all over Africa (Bashir 1989). The process is local variations, but the principle is that a field guard makes a noise when pest birds approach and usually accompanies the noise with throwing something at the birds. The noise can be made by shouting, banging a can, beating a drum or cracking a whip. The missile thrown can be a lump of mud flicked from the end of a stick, or a stone thrown with a sling or shot with a catapult. The important element is that there is a physical threat to the bird which may kill or injure it, which accompanies the noise. The guard may sometimes run across the field to chase the birds out, especially if he is in charge of an area of a hectare or more. Visibility may be improved by building a platform so that the guard has a clear view over the top of the field. His scaring capacity may be increased by having ropes with rattling cans distributed along them which he can jangle if a flock approaches. Sometimes bird scarers also place pieces of cloth in the field or bits of silver paper that glisten or build scarecrows, but these suffer the same habituation problems that other scaring devices do. The bird scarer has to be in position at first light because pest birds start feeding as soon as it is light. Quelea have the capacity to feed very quickly, so if a scarer arrives one hour after it is light, considerable damage to the crop may already have been done. Although the bird pressure tends to drop off during the hottest hours of the day, it can still occur and it can continue to dusk. The scarer's job is an arduous and time-consuming one. Studies in Chad have shown that there is a correlation between ownership and efficiency. If a person is protecting his/her own field, the efficiency is highest. If the task is given to the person's children, efficiency drops. If hired labour is used, it is even less efficient. When the manager is present, the labourers are very active, but when he is absent, they may rest in the shade. Nevertheless studies have shown that, in almost every cirmstance, an active, motivated, person can efficiently protect up to about one hectare of crop.

Many devices that have been developed outside Africa have been tested on quelea, including various sound-making equipment and scarecrows. All of them suffer the habituation problem. After becoming habituated, quelea flocks fly up when a cannon makes its bang, and a few seconds later land back on the crop to continue feeding. Because of the cost of importing these devices, they have not been tested in combination to see if the habituation effect can be reduced by changing the scaring device at frequent intervals. The management input would also be considerable, which has discouraged the attempt to test them.

Chemical repellents have been tested on various bird pests in Africa (Bruggers and Ruelle 1977, Bruggers *et al.* 1981). For example, newly sown rice was damaged by wading birds and by waterfowl in the Senegal River valley. Mesurol used as a seed dressing improved the yield in treated fields compared with untreated ones. Mesurol sprayed onto cereal heads has produced variable results. In some cases, the yields in treated fields were at least four times higher that in control fields. For sorghum in Ethiopia, treated areas lost 2-22% to birds, whereas untreated fields lost 23-42%. In Kenya, the treated field lost 6% while the untreated lost 50%, and in Sudan the respective figures were 8.4% and 16.2%. The cost of mesurol in the 1980s was about US$ 150 for one hectare for full-cover treatment, but it is possible that spot spraying may be sufficient. It is expected that to protect a field, two treatments would be necessary, one at milky stage and one at the soft dough stage, bringing the cost to about US$ 300/ha. There should be about three weeks between the last spray and the harvest, to ensure that there is no contamination of the crop.

A great deal of research has been carried out on developing **bird-resistant varieties** of cereal crops in Africa. These include modifying the taste, for example by increasing the tannin content which gives a bitter taste, or by changing the structure of the panicle, for example by having long awns (Bullard and Gebrekidan 1989). Experiments have shown that in preference tests, birds avoid high tannin cereals and prefer grain without awns. Unfortunately high tannin cereals such as sorghum are also less preferred for human consumption, and farmers have difficulty selling it. If birds have no choice, they will eat awned grain but they tend to attack it from the bottom up instead of the top down. The implication is that if, for example, all farmers grew rice with long awns, birds would quickly get used to them and adapt their feeding behaviour to deal with it. Another technique that has been developed is to adjust the **planting/harvesting time** so that the peak of bird damage is avoided. In Chad and Cameroon, it was shown that rice planted early so that it can be harvested by mid-June avoided almost all bird damage, whereas rice ripening after mid-June coincided with the arrival of large migratory flocks of quelea and greatly increased damage levels (Elliott 1979). The experience was similar in northern Tanzania where short-cycle crops planted in February avoided damage, whereas those planted in March/April were decimated (Doggett 1982). Another agronomic technique to avoid bird damage is **crop substitution**, whereby the crop which is attacked is replaced with one that is not. Quelea do not attack maize. If the small-grain crops are substituted with maize, the problem is solved, but maize needs more rain than wheat or millet, so substitution can only be done in areas that receive enough rainfall. The quality of the crop in respect of **good weeding** may influence the bird pressure. Studies have shown that rice fields in Mauritania (Peveling pers.comm.) and wheat fields in Tanzania (Luder 1985) that are infested with weeds attract quelea. The quelea feed first on the weed seeds which are their natural food and then turn to the rice or wheat. Clean well-weeded fields are less likely to suffer damage. **Clean surroundings of crop fields**, removing tall grasses or trees that are used as convenient perches from which the pest birds launch their attacks on the fields also discourages bird damage.

Several experiments have been carried out using various sorts of **netting and fibres** to protect crops from birds or to catch them before they enter the crop. These can vary in complexity from fully built cages with wooded or metal frames and wire netting, to plastic netting that is pulled over the crop (Bruggers & Ruelle 1982, Allan 1997). The netting enclosures are the only method yet devised for bird control which is 100% effective. The cages have been used for particularly valuable crops such as seed or hybrid development, because the cost of the frame structure is expensive. Plastic netting, Xironet, has been tried in Tanzania with initial success, but it was found to be easily torn by strong winds. Bruggers and Ruelle tabulate 13 different trials using Xironet, Conwed, and locally available fish nets. The nets were found to be effective against quelea, starlings, Ploceus weavers, bishop birds and the Red-headed Quelea. The quality of the fish-netting was not high and it tore easily after only one season. The Conwed netting was a heavier duty plastic and was reusable, but was heavier to handle and support. Bruggers and Ruelle calculated that the cost of netting and it support structure was US$ 1,000 – 3,000 per hectare in 1982. Another material, Crylde, which is an acrylic unknotted fibre, has been tried out. The material is teased out so that it covers the whole field and has been successfully used for protecting rice nurseries on irrigation schemes where the transplanting system is used. Another form of netting is described by Allan is to use a mesh of **black cotton thread** spread over the crop. It is sufficiently thin to be almost invisible and the pest birds fly into it and are frightened away. The use of this method is not documented, with no details given of the spacing of the threads and how easily they break, but it is said that because the birds cannot see the threads, they do not become habituated to them. **Tapes** manufactured in Japan that are coloured on one side and silver on the other have been tested on a variety of birds including parakeets, in Bangladesh, Philippines, India and the United States (Bruggers *et al.* 1986) and in Niger on quelea (Dorow 1991). They are twisted and stretched across the fields. To the human eye, they produce a disorienting pattern of colour and flashes of silver, accompanied by a vibrating sound when the wind blows. Although some comments suggest that the birds become habituated to the tapes, no quantification for this statement is given (Allan 1997). Other trials that have been done with proper quantification (Dorow 1991), in which the protection of rice with tapes placed at 3m intervals across ten rice fields in Niger was compared with a similar number of unprotected fields. The mean damage level in protected fields was 0.3% compared to 6.5% in the unprotected fields. This suggests that taped fields were 20 times better protected, but the bird pressure on the sites selected was low if damage on the unprotected fields reached only an average of 6.5%. The tapes might not work so well, if the pressure was higher.

3.3. Existing Bird Problems/Solutions in South West Nigeria:

3.3.1 At the **Federal Government Level:**

The Ministry of Agriculture and Rural Development said that responsibility is taken only for transboundary bird pests, i.e. those species which carry out movements across the national frontier. Farmers are expected to look after so-called resident species. In effect, this means that the Federal authorities deal with Red-billed Quelea control, whereas farmers deal with the other species including the various Ploceus weavers and the Red-headed Quelea. The Federal authorities had contracted two aerial spraying companies to provide 50 flying hours in 2007 and in addition they had two vehicles equipped with micronair sprayers for ground applications. These resources were available for quelea control only for the states in the North-East, Bornu, Yobe, Adamawa and Bauchi. Further south and in the South-West, it was expected that state governments would have their own resources. The Federal authorities were not concerned about the environmental side-effects of spraying. It was noted that sometimes the aerial spraying companies had difficulty in mobilizing their aircraft because of a shortage of suitably experienced pilots. In connection with rice production, it was noted that the Federal Government planned to ban importation of rice by 2008, in order to stimulate local production.

3.3.2 At the S**tate Level:**

The states, as represented by the Agricultural Development Programmes (ADP), noted that bird pests were a threat to rice production. **Ekiti** had been a leading producer of Ofada rice (12 varieties are called Ofada), but its position was being threatened by farmers abandoning rice production because of losses to birds. It was estimated that there were 17,680 rice-growing families in the state. State subsidy to encourage rice production had included 600 kg of seed (₦ 120,000) and access to loans. The ADP was promoting improved varieties of rice which would increase yields from the present level of 0.8-1.0 tonnes to 2.5-3.5t. Farmers did not request the ADP to carry out lethal control of the pest birds because it was well understood that the pest bird distribution was patchy with numerous small concentrations that did not make good targets.

In **Ogun** state, the ADP officer said that 40% of production costs were used on controlling birds. The ADP had tried carbide cannons as a bird scaring device but the birds had become used to them. Experience had shown that the efficiency of traditional bird scaring depended on the commitment of the labourers that were hired and on whether the farmer properly supervised the scaring. The ADP confirmed the position of Ekiti that killing the pest birds was not a practical option because the birds were not sufficiently concentrated to present good targets. It was not possible to meet officials from the ADP in **Osun** state.

3.3.3. At the **Farmer Level:**

Both farmer representatives (officials of the state chapters of the Rice Farmers Association of Nigeria [RIFAN]) and rice farmers themselves were met in all three target states. The figures they gave for various components of rice production varied, but there was consensus that birds were the most important constraint. It was also agreed that rice was not grown in contiguous areas but was often in small isolated farms of a few hectares, with each farm surrounded by forest. In **Osun** state, the RIFAN Chairman said that there were 800 farmer members of the Association. She reported that in 2006, the state had provided loans to rice farmers of ₦30 million which had been used for seeds, fertilizer and chemicals, but not specifically for bird scaring. Farmers in all three states said that the normal **crop calendar** was to carry out land preparation in February and early March, planting took place from mid-March to mid-April, milky stage was from mid-June to mid-July and harvesting could start in mid-August and be finished by the end of September. If the rains were late to start, the crop calendar could be delayed by up to a month. There was no system for trying to encourage farmers to synchronize planting in order to dilute bird damage. Synchronization would also be difficult because rainfall could be patchy and could be a good enough to start planting on one farm while another one only a kilometer away could still be dry. It was noted that, at least in Ogun, farmers who planted earlier or later than the majority tended to attract more bird damage than the average. Most rice farmers cultivate about one hectare of crop, but a few have 10ha or even 15ha. The only women farmers that were interviewed (in Ogun) had about a hectare each, whereas the men in the same village had at least 4ha. There was some confusion about Upland and Lowland rice, since both were grown sometimes even by the same farmer. Although strictly speaking Ofada rice is upland rice, farmers appeared not to make the distinction and sold their rice as Ofada whether it was upland or lowland. Lowland rice is planted in May and harvested in November/December, and generally has a higher yield. The information collected by the consultancy team concentrated on the upland rice.

On the **bird species** responsible for damage, farmers were not able to be precise as to which birds were involved although they were shown pictures of the potential suspects. Some of the farmers referred to the birds generally as “quelea”. From their descriptions, it appeared that the damage caused during the milky stage was mainly by Bronze Mannikins, but the main culprits of soft-dough to fully ripe rice were yellow and black weaverbirds, probably the Village Weaver, assisted to some unknown extent by the Red-headed Weaver, and probably by other Ploceus weavers. The RIFAN Chairman in Osun state also mentioned large white birds causing damage to ripe wheat. This probably referred to the Cattle Egret *Bubulcus ibis*, which is an insectivore specializing on eating grasshoppers and caterpillars, an activity normally considered beneficial for farmers. It is possible that if a Cattle Egret is present in a rice field which contains very dry grain, for which the harvest is delayed, it may knock some grain to the ground while searching for insects, but such circumstances are likely to be rare and it should not be considered a pest.

Bird-scaring techniques used by farmers were broadly similar in the three states but there was some variation between individual villages, but since there was no activity in the rice fields, the descriptions given could not be checked. The technique involves shouting, banging cans, beating drums, chasing the birds out of the fields, and using catapults to shoot stones or mud at the birds. Some farmers stretched tape-recorder or video-cassette tapes across the field to scare the birds. The tapes produced a vibration sound if they were stretched tightly and if there was wind. One farmer said that the tapes worked better in areas in which rice had not been grown before. The usefulness of the tapes was doubted by many farmers who noted that the birds became used to them after a few days. There was consensus that the bird scarers had to be present in the fields from first light at about 06:00 hrs until dusk at about 18:30 hrs, and that if they were late to arrive, some serious damage could occur. In most cases labourers were hired to do the scaring, most often being secondary school pupils whose holiday period coincided with the ripening season of July and August. The farmer had to supervise the labourers if he expected the bird scaring to be effective, and this required him to be also in the field all day. Women farmers were expected to provide food to the scarers which they did at about 08:00 hrs and they then remained in the field for the rest of the day to provide supervision. A few farmers did their own scaring and they were helped by their children at the week-end or in the afternoon after school had finished. The duration of bird scaring was about 30-35 days. Once harvesting had started with people in the field cutting the rice, scaring was no longer necessary. The number of bird scarers required to protect one hectare varied from one to two, with the majority considering that two per hectare were required. The cost reported by different farmers ranged from ₦ 133 – 500/person/day, with 500 being the most frequently mentioned figure. The total investment was therefore ₦ 30,000-35,000 per ha. It was noted that there was no system of paying bonuses to bird scarers if they kept the damage to low levels.

One **variation on bird scaring** described by Iboro villagers was the scarers' use only of catapults. They had found that if they shouted and made a noise, this had the effect of attracting the birds. If they used the catapults only and shot at the birds every time they approached the field, this was the most effective method. It is not inconceivable that birds could come to associate noise with the presence of ripening rice, and that the noise could attract them. Comparisons could be made between the "silent and deadly" approach to scaring and the traditional method of combining noise and catapults.

In all the villages visited, mention was made of the **use of juju** to scare away the birds. It was described as a "medicine" purchased from a traditional medicine man which then had to be buried in the field to be protected and also placed at the four corners of the field. The pest birds were said to fly over the field but did not land if it was protected by juju, and moved on to find an unprotected field. One man said that he had been using juju to protect his 10ha of rice and had had no bird damage problems for several years. He had raised the subject at a RIFAN meeting, but there had been no agreement to use it systematically. All the farmers who mentioned the technique said that the use of juju required that a number of conditions should be met;

no woman urinating in the field, no menstruating woman to pass through a field, no cutting of wood in the area, no shouting. If these conditions were not met, the juju would not work. The majority of the farmers interviewed said that the juju usually did not work like it used to and they considered it a method that dated from the "old days". One explanation was that in times past the bird population was much lower than it was now, which allowed the juju still to work. They felt that their bird scaring had moved on to using catapults and noise to keep the birds out of the fields. One staff member at the University of Agriculture in Abeokuta (UNAAB) said that he had taken video footage of flocks of birds flying over a juju protected field and landing in an unprotected field, but he was unable to show the video footage to the consultants as the equipment was not available. The juju he had seen had been placed on sticks at the corners of the field, but the sticks were not more than 0.5m tall, so they did not show above the crop and would not have been easily seen by the birds. None of the farmers could suggest how the juju might work, except that it was an Act of God. Several farmers said that medicine men would not reveal all the components of their juju as they wished to guard the secret of their medicine and preserve their market.

Other scaring techniques used by farmers included: using a specially designed can which produced a high pitched sound when the wind blew; keeping fields clean of weeds, as weeds attract pest birds, and cutting down long grass surrounding a farm, so that convenient perches for resting pest birds are fewer; in one village, one farmer sprayed a poison on the edges of his field, many birds died, and the number of birds attacking his field decreased, but he removed the label from the container and would not reveal what it was; a few farmers build platforms with shade where the bird scarer can sit and survey the field;

The figures given by the farmers for the **selling price of their rice** varied considerably; ₦ 350/kongo where 1 kongo= 1.2 kg= ₦ 292/kg= US$ 2.3/kg (Ogun); ₦ 150/kg = US$ 1.2/kg (Osun); ₦ 150/kongo = US$ 1/kg (Ekiti); ₦ 250/kg off-season price = US$ 2/kg (Ekiti). The difficulty was that kongos of different sizes were used in different states, so these figures may need refining.

The **losses estimated by farmers** to be caused by birds varied. With bird-scaring, the losses were from 10-15% up to about 40%. Without bird-scaring, the loss could be from 90-100%. Most farmers, when asked how much of the crop was lost if there was no scaring, laughed and said there would be nothing left after a few days. A few farmers said that with the use of juju, they had not needed any bird scarers and losses had been negligible. In all three states, anecdotes were given of farmers being away from their field for a few days and returning to find that the birds had consumed virtually everything.

3.3.4. At the **Institutional Level:**

Two institutions were visited, the **Africa Rice Center (WARDA)** Nigeria Office, based at the International Institute of Tropical Agriculture (IITA), and the University of Agriculture at Abeokuta (UNAAB). At WARDA, it was noted that at the Africa Rice Congress held in Tanzania in 2006, birds were identified by participants as the top constraint to rice production in Sub-Saharan Africa. WARDA expected that the new Nerica varieties of rice would make an impact in improving yields in Africa.

WARDA officers said that birds had been a problem in attacking their experimental field trials of rice and they had decided to use nets to cover the crop. The net had been imported from the Philippines at a cost of ₦ 186,428 for one hectare. The net, which had a mesh size of 2cm, had been of great benefit for the trials and no bird damage had since occurred. The net was still usable after 10 years. A supplier of nets had also been identified in Ibadan, and had sold WARDA a small quantity of netting for further trials at a price much lower than the Philippine product but with a thinner fibre. The nets were erected during the plant-growing season, but had to be taken down during the dry season because of the danger of bush-fires. WARDA officers said that they thought the netting could be applicable to farmer rice cultivation, but it would need a cost/benefit analysis. WARDA offered to research the use of netting by farmers through a post-graduate study if the necessary support for such a study could be found.

At **UNAAB**, officers had explained that some studies on bird damage had been carried out under a post-graduate programme entitled "Evaluation of Participatory Technology Development Approach in Rice Technology Dissemination in Selected States of Nigeria" by C.A. Enyo in 2005. Some observations had been made using video cameras which suggested that juju did work, but no experimental studies had been carried out under controlled conditions such as cage experiments. The study had also noted another technique where farmers placed sticks covered with glue in fields. When birds landed on them, they became stuck, flapped about and gave distress calls which frightened other birds out of the field. Other farmers had used fish-nets around the edge of fields to catch birds flying in, and this had also had a deterrent effect.

Efforts were made to obtain **published reports** from the institutions visited, from the Federal Ministry of Agriculture and from the ADPs, but nothing of direct relevance to the bird pest problem in South West Nigeria was obtained. From personal sources, two papers on the Village Weaver were obtained (Funmilayo 1975, Funmilayo & Akande 1976). The first paper described a technique for catching Village Weaver adults on the nest at night and using them as cage birds. The second paper reviewed the pest status of the Village Weaver, noting that colonies contained 100-500 nests and could be permanent or temporary. It was also noted that the bird was responsible for a variety of crop damage, with a preference for rice during the ripening season, but also caused losses to maize and fruit crops, and indirect damage to oil palms, coconut palms, guava and orange trees through defoliation for nest building. A list of known publications on bird pests in Nigeria/West Africa, which can be accessed with further personal searches, is given in Annex II.

4. DISCUSSION

The information that was collected by the team involved no direct measurements because the visits took place during the dry season. The results are therefore based on second-hand sources which mean that they may sometimes be unreliable. Nevertheless, farmers' perceptions of a problem are very important because they have a strong impact on production and on whether individuals decide to start rice farming or to expand their farms or to leave farming altogether.

The consultant team was convinced that birds are genuinely a serious constraint to rice. Consideration should be given to whether resources should be made available to obtain objective/empirical measurements of average losses that Ofada rice producers suffer. Such measurements involve a laborious procedure requiring that staff collect samples from randomly selected fields and compare the weight of damaged and undamaged panicles (Elliott 1976). The method assumes that the birds are attacking the panicles randomly and not selecting bigger or smaller ones. If there is high variability in the level of damage, then more samples need to be collected. However obtaining an accurate measurement of damage may not be a priority for PrOpCom. If the goal is to encourage farmers to grow more Ofada rice, the requirement is that they should feel confident that the measures they take to protect their fields against birds will be successful. The PrOpCom priority may be more to improving existing crop protection techniques and testing new ones, rather than attempting to quantify the existing level of damage.

The circumstances in which birds cause damage to rice in Ofada growing areas, being a forest habitat, is significantly different from those in other parts of Africa where major efforts have been made to control mainly quelea, being savannah habitat. The species composition is also different, most likely being Village Weaver, Red-headed Quelea, and Bronze Mannikin, which occur in flocks of hundreds, compared to mainly Red-billed Quelea which occurs in flocks of thousands, sometime hundreds of thousands. The distribution of the birds is also different in Ofada areas, because the pest birds do not apparently assemble in large concentrations either to breed or to roost, and therefore they do not present targets for lethal control as practiced elsewhere in the world or elsewhere in Sub-Saharan Africa. Some of the species, such as the Village Weaver, do breed in the vicinity of rice fields and close to or within villages. The only form of lethal control that seems applicable is for farmers to attack these small colonies, especially when they have eggs or chicks in the nest, and discourage the pest birds from residing in the area. They could pull the nests out of the trees with long hooked poles, use Funmilayo’s trap to catch the adults on the nest, or, as a last resort, cut the tree or trees down. It is said that in some areas, farmers do not like to harm Village Weavers because they bring the village luck. , When this was mentioned by the consultants, the villagers seemed to find the destruction of the nests to be no problem.

The existing techniques for bird-scaring, employing scarers armed with catapults and sometimes with noise-making devices, appear to be functioning adequately provided that the scarers are supervised. The technique is reported to keep the damage down to about 20% of production, but is costly and arduous. The question is whether this technique for protecting the crops could be improved. The consultants’ view is that there is room for improvement, but that these should be introduced as part of an Integrated Pest Management (IPM) package in which all aspects of the rice production cycle that have an impact on reducing bird damage are examined with farmers. The farmers themselves then come to understand how these different components interlink and select the best combination of actions for avoiding bird damage as is most appropriate for their individual circumstances. For example, the results suggest that there is advantage in farmers from the same village synchronizing their planting, so that bird damage is distributed among as many fields as possible, and the individual farmer suffers less. While some farmers recognized the advantage of clean fields and clean surrounds to their farms, others may not realize that both these actions reduce the attractiveness of their fields to pest birds. In respect of the scaring process itself, no platforms for bird scarers were observed in the fields which allow a scarer a good view of his field and of approaching flocks of birds. Such platforms may sometimes be built, but farmers need to understand the advantage that they confer. Also the use of ropes stretched across a field with cans that clank if pulled could improve the quality of scaring. It appeared that they were rarely, if at all, used in Ofada growing areas. Another component is to stress the importance of harvesting the crop as soon as it is ready. Production may be significantly reduced if harvest is delayed, so that the rice becomes very dry and shatters easily when it is touched. Some farmers informed the consultants that they had difficulty hiring labourers for the harvest, which could cause delays. The delay in harvesting may also allow pest birds to continue to feed on the crop longer than necessary, and as the crop dries, they may not only eat the grain but cause some of the grain to shatter. Delayed harvesting could also increase the cost of hiring scarers by prolonging their time in the fields.

Many scaring devices exist on the international market. A few of them have been tried in Nigeria but without success because of the tendency for the birds to habituate to them after a few days. The only devices that seem to be worth testing are the reflective ribbons and the black threads stretched across the fields. Both of these techniques are relatively cheap although the ribbons have to be imported from Japan. Results from Niger suggest that the ribbons worked in savannah areas, provided that they are set properly taught and at 3m intervals, but it is not certain that they will work in forest areas. A small investment in time and resources would show if they are useful or not. The black thread system is not well documented, but as it would be very cheap to test it, it may be worthwhile.

There does not seem to be a strong case for further testing of chemical repellents on rice. Although some of the results in the 1980s were encouraging, the technique is expensive while not guaranteeing that it will work. The development of bird-resistant varieties of rice also seems a forlorn hope that may involve much research with little assurance that a satisfactory result will be produced. Birds have a capacity to adjust their feeding pattern to any structure of a panicle and any attempt to create a rice variety that tastes bad to birds may prove to taste bad to humans too.

Further study is needed to understand how bird pressure on rice changes during the year and when it is at its peak. If such information was available, further investigation could be made on the advantage of earlier or later planting dates, so that the crop ripens when the bird pressure is low. Equally, investigation could be made of using short cycle rice in order to avoid peak pressure times, if such peaks exist.

On one occasion, farmers reported that poisons had been sprayed onto crops and had killed many birds. The matter was subsequently discussed with an ADP officer (Ogun state) and it was suggested that it should be investigated because of the potential human health and environmental hazard. Use of poisons sprayed onto crops should be discouraged and if possible forbidden.

Before embarking on the field visits, the consultants had discussed the possibility that enclosure netting that forms a physical barrier between the crop and the bird might be worth investigating for Ofada rice. The technique has the advantage that it is the only method that provides 100% protection of a crop, provided that the netting is not torn by wind or by other factors. During the field visit, the possibility was further discussed with farmers. In almost every case, interest was expressed but with the proviso that it depended on the cost. The idea was given further encouragement when the team was informed of the satisfactory result experienced at WARDA. The WARDA net not only protected their rice trials but was also re-usable over ten years. There are many uncertainties about using enclosure nets at the Ofada rice farm level. These include obtaining preferably a locally manufactured net which has a similar durability to the imported Philippine net (UV resistant) and which can be installed with reasonable ease using ropes, and poles cut from the forest. Ideally the net should be installed as the milky stage begins, but this may prove difficult to do without damaging the growing crop. It may be necessary to grow the crop in lanes so that the net can be erected without causing damage to the rice plants, or to erect it immediately after planting. Once installed, it needs to be proved that a mesh-size of 2cm keeps the pest birds out and that the net is resistant to wind as experienced in typical Ofada situations. Other problems can only be determined by testing the nets, such as whether birds are capable of breaking it, or nocturnal rodents might chew through it, leaving an entry point for birds. The possibility that the nets might be stolen or vandalized also needs to be checked, although farmers assured us that this would not be a problem.

The cost structure for the netting is also a key element in deciding even whether field trials of the nets to investigate the aspects described above are justified. In consultation with PrOpCom Agricultural Economist Tom Valla, a table of the cost element and the break-even point was prepared (Annex III). This was based on the import price of the Philippine nets purchased by WARDA at ₦ 186,000 for one hectare. If local manufacture of an equivalent quality can be found, the purchase price might reduce. The calculations were based on the net lasting at least 10 years as the WARDA one has done, but perhaps under village conditions the durability will be less. The expected savings resulting from use of the net were expected to be, first, savings in the farmer’s time spent supervising his scarers, which he could use for other income generating activity. It was assumed that the average holding per farmer was 4ha. If the average holding is smaller than this, the saving will increase. The second source of saving was that the farmer would no longer have to hire labour for scaring. The duration of scaring was assumed to be 35 days, two scarers being required per hectare and the daily payment was ₦ 500/day. The original value given in the table for paddy was ₦ 2,500 for a 75kg bag or ₦ 33.33/kg. In the field, the team was quoted prices of ₦ 60/kg in Osun and of ₦ 57/kg in Ogun . Given the price of 33.33/kg, the breakeven yield if the loss with bird scaring is 20%, would be 2,563 kg/ha. If the value of paddy is as high as ₦ 60, the breakeven yield would be 1,424 kg/ha, as shown in the table. This latter yield is well within current yield ranges, which suggests that if PrOpCom improves yields, the netting will quickly become profitable. The consultants’ view is that, given that PrOpCom is attempting to improve Ofada rice yields to as much as 2.5-3.0 tonnes/ha, there is ample justification for demonstration trials of enclosure netting during the forthcoming growing season. At least one demonstration trial covering one hectare should be set up in each of the target states.

5. RECOMMENDATIONS

The consultants recommend:-

1. That, if it is considered a priority for PrOpCom, local staff should be hired and trained to carry out objective/empirical damage assessments, and should then carry out randomized assessments of bird damage in the three target states;
2. That IPM Farmer Field Schools be organized in the three target states to examine the various ways in which bird damage can be avoided or reduced by the farmers themselves. This examination would include assessing the bird pressure to determine when the peak is;
3. That samples of reflective ribbons and black threads should be purchased and tested in a few sample fields, both on their own and when used in combination with bird scaring.
4. That demonstration plots, each of one hectare, using enclosure netting, should be established in each of the three target states during the forthcoming milky stage in June/July 2007. In order to do this, local sources of manufacture need to be found. In discussion with manufacturers, the best way of producing the net must be decided, including how the strips of net will be attached to each other. The netting must meet specifications of durability, visibility (black?), mesh size (2cm^2) and strength. The best way to erect the net will also need to be found, which will cause minimal damage to the growing crop.
5. Observations should be made on the efficacy of using juju, but given the number of excuses that the system contains if it does not work, such observations should not be a priority unless farmers themselves, or their representatives, insist that it be included.

6. ACKNOWLEDGEMENTS

The consultants would like to record a special vote of thanks to Dr. Oshiname who accompanied the team throughout its visit. His excellent contacts in the target states made the visit much more fruitful and easier than it would otherwise have been and he also contributed greatly to the discussions. The consultants would also like to thank the Federal Ministry officials, the ADP officials, the RIFAN officers, the farmers and both WARDA and UNAAB for the time and interest that they gave to the subject. Last, but not least, PrOpCom staff in Abuja was most helpful in assisting the work, and deserve our gratitude.

7. REFERENCES

Allan, R. (1997). The grain-eating birds of Sub-Saharan Africa: Identification, Biology, and Management. Natural Resources Inst., Univ. Greenwich, Chatham, UK.

Archer, A. (1995). The Indian House Crow *Corvus splendens* control programme in Zanzibar and Pemba. Review for the five years 1990-1995. A consultant report to Finnida and Zilem, Zanzibar.

Bashir, E.A. (1989). Traditional African practices for preventing bird damage. In: Bruggers, R.L. and Elliott, C.C.H. (eds), *Quelea quelea* – Africa's Bird Pest. Oxford Univ. Press.

Bruggers, R.L. and Ruelle, P. (1977). Bird losses in Senegal rice significantly cut. The Rice Journal, Nov./Dec. 1977: 10-14.

Bruggers, R.L. and Ruelle, P. (1982). Efficacy of nets and fibres for protecting crops from grain-eating birds in Africa. Crop Prot. 1 (1): 55-65.

Bruggers, R.L., Brooks, J.E., Dolbeer, R.A., Woronecki, P.P., Pandit, R.K., Tarimo, T., All-India Co-ordinated Research Project on Economic Ornithology, Hoque, M. (1986). Responses of pest birds to reflecting tape in agriculture. Wildl. Soc. Bull. 14: 161-170.

Bruggers, R.L., Matee, J., Miskell, J., Erikson, W., Jaeger, M., Jackson, W.B., Juimale, Y. (1981). Reduction of bird damage to field crops in eastern Africa with methiocarb. Trop. Pest Manage. 27(2): 230-241.

Bucher, E.H. and Ranvaud, R.D. (2006). Eared Dove outbreaks in South America: patterns and characteristics. Acta Zool. Sinica 52 (suppl.): 564-567.

Bullard, R.W. and Gebrekidan, B. (1989). Agronomic techniques to reduce quelea damage to cereals. In: Bruggers, R.L. and Elliott, C.C.H. (eds), *Quelea quelea* – Africa's Bird Pest. Oxford Univ. Press.

De Grazio, J.W. (1989). Pest birds – an international perspective. In: Bruggers, R.L. and Elliott, C.C.H. (eds), *Quelea quelea* – Africa's Bird Pest. Oxford Univ. Press.

Dorow, E. (1991). Lutte antiaviaire: Expériences menées dans la République du Niger. GTZ, Germany.

Doggett, H. (1982). Factors reducing sorghum yields: Striga and birds. In: Mertin, J. (ed.), Sorghum in the Eighties: Proc. Int. Symp. ICRISAT, Pantancheru, A.P., India, pp.313-316.

Elliott, C.C.H. (1976). Estimating bird damage to rice. Unpubl. Int. Rep., FAO, Rome: 360: 1-4.

Elliott, C.C.H. (1979). The harvest time method as a means of avoiding quelea damage to irrigated rice in Chad/Cameroun. J. Appl. Ecol. 16:23-35.

Elliott, C.C.H. (1989). The pest status of the quelea. In: Bruggers, R.L. and Elliott, C.C.H. (eds), *Quelea quelea* – Africa's Bird Pest. Oxford Univ. Press.

Feare, C. (1984). The Starling. Oxford Univ. Press

Funmilayo, O. (1975). A Purse-net for capturing village Weaverbirds. The Nigerian Field Vol. XL (3): 134-137.

Funmilayo, O. and Akande, M. (1976). Ecology and agricultural pest status of the village weaverbird (*Ploceus cucullatus* Muller) in south-western Nigeria. Ghana J. agric. Sci. 9: 91-98.

GTZ (1987). The Ecology and Control of the Red-billed Weaver Bird (Quelea quelea L.) in Northeast Nigeria. GTZ, Germany.

Inglis, I.R. (1980). Visual bird scarers: an ethological approach. In: Wright, E.N., Inglis, I.R., and Feare, C.J. (eds.), Bird Problems in Agriculture. Brit. Crop Prot. Council Publ., London, UK.

Lefebvre, P.W. and Seubert, J.L. (1970). Surfactants as blackbird stressing agents. Proc. Vert. Pest Conf. 4: 156-161.

Luder, R. (1985). Weeds influence Red-billed Quelea damage to ripening wheat in Tanzania. J. Wildl. Manage. 49: 646-647.

Meinzingen, W.W.,Bashir, E.A., Parker, J.D., Heckel, J-U., Elliott, C.C.H. (1989). Lethal control of qulea. In: Bruggers, R.L. and Elliott, C.C.H. (eds), *Quelea quelea* – Africa's Bird Pest. Oxford Univ. Press.

Mullié, W.C. (2000). Traditional capture of Red-billed Quelea *Quelea quelea* in the Lake Chad Basin and its possible role in reducing damage levels in cereals. Ostrich 71:15-20.

Murton, R.K., Isaacson, A.J. and Westwood, N.J. (1966). The relationship between wood-pigeons and their clover supply and the mechanism of population control. J. Appl. Ecol. 3:55-96

Newton, I. (1968). Bullfinches and Fruit buds. In: Murton, R.K. and Wright, E.N. (eds.), The Problems of Birds as Pests. Academic Press.

Newton, I. (1972). Finches. New Naturalist Series, Collins, London.

Schafer, E.W. (1981). Bird control chemicals – nature, modes of action, and toxicity. In: Pimentel, D. (ed.), CRC Handbook of pest management in agriculture, Vol. III. CRC Series in Agriculture, Boca Raton, Florida, pp. 129-139.

Slater, P.J.B. (1980). Bird behaviour and scaring by sounds. In: Wright, E.N., Inglis, I.R., and Feare, C.J. (eds.), Bird Problems in Agriculture. Brit. Crop Prot. Council Publ., London, UK.

Stables, E.R. and New, N.D. (1968). Birds and Aircraft: the Problems. In: Murton, R.K. and Wright, E.N. (eds.), The Problems of Birds as Pests. Academic Press.

Tahon, J. (1980). Attempts to control starlings at roosts using explosives. In: Wright, E.N., Inglis, I.R., and Feare, C.J. (eds.), Bird Problems in Agriculture. Brit. Crop Prot. Council Publ., London, UK.

Thearle, R.J.P. (1968). Urban bird pest problems. In: Murton, R.K. and Wright, E.N. (eds.), The Problems of Birds as Pests. Academic Press.

van der Walt, E., Meinhardt, H.R., Venter, A.J., Bouwman, H. (1998). Primary and secondary effects of Red-billed Quelea *Quelea quelea* control in South Africa. Ostrich 69 (3&4): 456.

Wright, E.N. (1968). Modification of the Habitat as a means of Bird Control. In: Murton, R.K. and Wright, E.N. (eds.), The Problems of Birds as Pests. Academic Press.

Wright, E.N. (1980). Chemical repellents – a review. In: Wright, E.N., Inglis, I.R., and Feare, C.J. (eds.), Bird Problems in Agriculture. Brit. Crop Prot. Council Publ., London, UK.

ANNEX 1

List of key informants and farmers in the Ofada rice producing areas who were met by the consultants.

S/n	Location	Contact	Phone	Activity	Bird Scaring Technique/Comments
1	Fed.Min of Agric.Abuja	Elder Ukagha Amogu	08033113681	Deputy Director Livestock Planning & Monitoring Services	Aerial spraying of avicides with hired aircraft.
2	‘’	Mr J. A. Ibitoye		Deputy Director Pest Control Services	Agro-Avian Monitoring. Aerial spraying
3	‘’	Mrs K. I. Babangida	08023468832	Chief Agric Officer	Bird pest damage reports scarce
4	‘’	Engr. A. A. Akintola	08033706343	Asst Director Fed. Min Agric & Rural Development.	Bird pests serious
5	Ogun State Agric Dev.Programme Abeokuta	Pastor Bode Adenekan	08055284349	Chairman (RIFAN) Ogun State.	Bird pests are most serious
6	RIFAN Oshun State	Mrs Salawu	08032239192	Chairperson (RIFAN) Osun State.	Weaver birds and Cattle egret implicated in damage.
7	ADP Ikole-Ekiti	Mr Johnson Omole	08032199643	Head Communication & Support Services; Asst. Coord. Nerica Project	Bird pests are most serious
8	ADP Ikole-Ekiti	Mr M. O. Oloruntoba	08057993688	Programme Manager ADP Ikole-Ekiti	Bird pests problem remain serious
9	ADP Ikole-Ekiti	Rev. M. O. Ogunniyi		Nerica Rice Co-ordinator	
10	ADP Ikole-Ekiti	Mr. Olu Ajileye	08068705676	Director Agric.Extension Services	
11	Farmers’ field at Ifaki	Mr. Joseph Kehinde Ojo	H55 Ilero St.	Farmer	
12	Farmers’ field at Ifaki	Mr. Kehinde Afuye	B55 Ado Rd	Farmer	
13	Farmers’ village at Igbemo	Mr Oluyede Lere Samuel,		Farmer, Financial Secretary RIFAN	juju used successfully for 10 yrs.
14	WARDA	Dr. Olupomi Ajayi,	08060194594	Coordinator (Nigeria)	Enclosure Netting used for rice
15	WARDA	Dr. Francis. Nwilene	08034339601	Liaison Scientist/Entomologist	‘’
16	UNAAB	Prof Akin Omotayo	08037223311	Director AMREC	‘Juju’ works but no expt. proof
17	UNAAB	Mr. T. Babs Alabi		Media officer, AMREC	Made video of bird pests
18	Lufoko, Ogun State	Farmers’ group		All male farmers	Birds damage serious
19	Iboro, Ogun State	Farmers’ group		Male & Female farmers group	No panacea for bird damage
20	Iboro, Ogun State	Mr. Adams Elegbede	08060173041	Farmer	
21	OGADEP, Abeokuta	Mr. O. A. Osiyoye,	08033777121	Head Seed Multiplication,	Pyrotechnic canon guns & juju

IITA- International Institute Of Tropical Institute; RIFAN - Rice Farmers Association Of Nigeria; OGADEP - Ogun State Agricultural Development Programme;

AMREC - Agricultural Media Resource and Extension Center; UNAAB – University of Agriculture, Abeokuta, Ogun State

ANNEX II

Published and unpublished reports on bird pests in Nigeria

Abifarin, A.D. (1984) The importance of rice awns in the reduction of bird damage. West African Rice Development Association Technical Newsletter. 5: 27-28

Adesiyun, A.A. (1973) Bird damage to cereals grown in the dry season in some parts of northern Nigeria. Samaru Agric. Newsletter. 15:34-37

Drees, E.M. (1980) Bird pests in agriculture in West Africa and their control. Unpubl. Internal Rep., Wageningen Agric. Univ., Natuurbeheer.

FAO (1980) Cereal crop pests in Africa, with particular reference to birds. Unpubl. Int. Rep., FAO/UNDP, Rome, Italy.

Funmilayo, O. (1973) A general survey of the incidences and control methods of vertebrate pests of crop plants in the Western State of Nigeria. Res. Bull. No.1, Inst. Agric. Res. Training, Univ. Ife, Ibadan. pp. 40

Funmilayo, O. and Akande, M. (1974) The ecology, economic impact and control of vertebrate pests of upland rice in the Western State of Nigeria. Res. Bull. No. 5, Inst. Agric. Res Training, Univ. Ife, Ibadan. pp.41

Funmilayo, O. and Akande, M. (1977) Vertebrate pests of rice in southwestern Nigeria. PANS. 23:38-48

GTZ (1987) The ecology and control of the Red-billed Weaver Bird (*Quelea quelea* L.) in Northeast Nigeria. Special publ. No:199

ANNEX III
Economic Cost of Bird Netting per Hectare

	Rate/ Period			Unit cost	
Investment Costs:					
Netting					186,000
Sticks		@ 3mx3m=	1000	10	10,000
Stick tops (calabash, tin can??)			1000	5	5,000
Storage for sticks & mesh (4 cu mt)					5,000
Total Investment Costs					206,000
Interest per annum @	30%				30,900
Depreciation					
Netting	10				18,600
Sticks	3				3,333
Stick tops	8				625
Storage	10				500
Total Depreciation					23,058
Total Annualized Investment Costs (interest + depreciation)					53,958
Annual Operating Costs					
Transport of sticks & mesh		To field	0.5	500	250
		From field	0.5	500	250
Install sticks & mesh			2	500	1,000
Remove sticks & mesh			2	500	1,000
Less cost savings:					
Savings in managers labour		35 days x 0.25	8.75	500	(4,375)
Savings in bird scaring		35 days x 2	70	500	(35,000)
Total Annual Operating Costs					(36,875)
Total Annualized Costs/ha					17,083
Value of paddy at harvest/75 kg. bag @ N 60/kg			4500		
Cost in terms of paddy (kgs)					285
Breakeven yield if loss in yield is 20% with bird scaring & single crop					1,424