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FIRST APPROXIMATION OF CROP DAMAGE IN SUDAN BY THE QUELEA

PD-AAA6-210-A1

ATTACHMENT A
TO PES - 2/80

## Frontispiece

The black-faced dioch or red-billed weaver (Quelea quelea) is a serious pest to small-grain farmers in Africa. It has the distinction of being the most numerous and perhaps the most destructive bird in the world. It is known to adversely affect the agricultural economies of between twenty and twenty-five nations by its depredations of cereal crops such as millet, sorghum, wheat, and rice.

DRAFT REPORT FOR USFWS/DWRC, AID/W-DSB, AND USAID/SUDAN

Preliminary Assessment of Damage by Vertebrate Pests (Quelea and Other Birds) to Cereal Crops in Sudan and Certain Other East African Countries
1971-1979

This report is based on the collection of foundation data for Quelea and other pest birds in Africa by Denver Wildlife Research Center (DWRC) biologists; Ministry of Agriculture (MOA) Sudan, counterparts; and Food and Agriculture Organization (FOA) grain-eating bird pest project staff. Additionally, the attached list of references indicates the pertinent sources reviewed in searching for reliable damage assessment information.

Cereal crop damage assessment data are being collected by FAO and will be available for the East African countries of Tanzania, Somalia, Kenya, Ethiopia and Sudan by the end of 1981. This will be a three-year analysis; some of the preliminary data are included in this report. USAID/DWRC continues to cooperate closely with this FAO project in the gathering and exchange of information dealing will all phases of the Quelea and other pest species.

The preliminary estimates of extent of damage and seasonality of destruction to cereal crops in Quelea habitat are tabulated in the attached tables. These figures are based primarily on a percentage loss to cereal crops against anticipated annual production. Until more field damage assessment percentages are obtained to increase the present number of samples, these percentage losses

can by extrapolation be weighed against known areas of production and average yields in Sudan and other East African countries. Tables are given for Sudan which depict the area, production, and average yields for sorghum, millet, rice, wheat and corn. These tables include croplands of the traditional, mechanized and irrigated farms, allowing for the projection of annual percentage losses or calculation of potential benefits through reduction in crop losses. This cropland information was adapted from tables by the Sudan Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

Assessments of damage gathered by DWRC biologists and seconded Plant Protection Department counterparts are based on a study plan (PES Attachment No. 14) work unit titled "Bird Damage to Small Grains in Selected Provinces of Sudan." The objective of this study is "to determine the loss of grain sorghum caused by pest birds in a select province dependent on weather conditions and other variables." (See Table 6 ).

"A. There is a need to evaluate and accurately assess damage caused by quelea and other species to cereal grain crops such as sorghum, millet, rice and wheat.

"B. There are known assessment techniques but these require modification for African conditions.

"C. The season, location, severity and percent of damage will be determined."

# INTRODUCTION

Vertebrate damage in agriculture involves a variety of crops and species of animals, primarily birds and rodents. Direct losses occur typically at planting and sprouting, during the milk or dough stages (for grains), just before harvest, or under post-harvest storage conditions. Some damage may be mechanical, as when crops are trampled or dislodged by animals. Losses may alter the food value, as when rats selectively remove the germ from stored corn, or may result from contamination with urine, feces, feathers, or hair.

Losses to birds are less well documented than those to rodents. Various species of parrots, parakeets, blackbirds, weavers, doves, seedeaters, pheasants, and waterfowl are among the types of birds known to cause damage in agriculture around the world. Actual losses are difficult to assess because damage is usually concentrated in limited areas and, due to the mobility of birds, is often seasonal, sporadic, and hard to predict.

Basic objectives of the Vertebrate Pest Research project are to: (1) increase the available human food supply by reducing damage to field crops caused by noxious birds and rodents; (2) develop integrated control programs within Sudan in areas suffering losses from grain-eating birds and rodents; (3) appraise the nature and magnitude of quelea bird and rodent losses in Sudan; (4) develop indigenous capabilities to evaluate and deal with vertebrate pest problems;

(5) institutionalize in-country research and control programs; and (6) coordinate activities with other international organizations to maximize results.

Quelea in the Sudan

The red-billed weaver, or quelea (*Quelea quelea*), is found in some 25 African countries and is a serious pest of cereal grain crops such as sorghum, wheat, millet, and rice. In the Sudan, quelea occupy some 90 percent of the country's grain production areas. DWRC investigations during late 1977 (see 1977 Annual Report) gave credence to the widely held belief that quelea are the most destructive birds in the world. In addition to quelea, there are other bird and rodent damage problems in Sudan and other nations of Africa that are of significant economic importance.

Quelea biology, migratory patterns, and breeding habits in East Africa have been summarized in DWRC Annual Reports. The habits of the subspecies found in Sudan, (*Quelea quelea aethiopica*) are much the same. Table 1 summarizes major quelea activity patterns in Sudan relative to roosting, nesting, and occurrence of crop damage in sorghum, wheat, and millet. Figure 1 illustrates the general distribution of quelea and other important grain-eating birds in the Sudan.

**Table 1.** Major periods of roosting, nesting, and crop damage by quelea in the Sudan.

| Area | Period of rainfall | Large concentrations of roosting | Nesting | Cereal crop damage |
|---|---|---|---|---|
| Northern Sudan | June-Sept. | March-April | Sept.-Oct. | Sept.-Nov. (dry farms)<br>Feb.-March (irrigated farms) |
| Southern Sudan | March-Oct. | undetermined | undetermined | Oct.-Nov. |

Quelea in Sudan can be classified as locally migratory and able to travel hundreds of kilometers to favorable feeding areas. Banding in African countries has shown that migrations can amount to 1,500 km. Quelea from Ethiopia can be expected to enter eastern Sudan where sorghum production has increased to several million feddans (1 feddan = 0.415 ha) over the past several years. These fields have replaced the grasslands used extensively by quelea in the past.

Figure 2 outlines the sorghum-growing areas and major quelea habitat of Sudan, including breeding and roosting sites that overlap almost all of the major grain-growing area. Ninety percent of the grain production in Sudan occurs between latitudes 8° and 15° N. and longitudes 23° and 37° E. This large grain-producing region forms ideal breeding grounds for quelea because of the availability of forests and tall grasses surrounding the cereal fields.

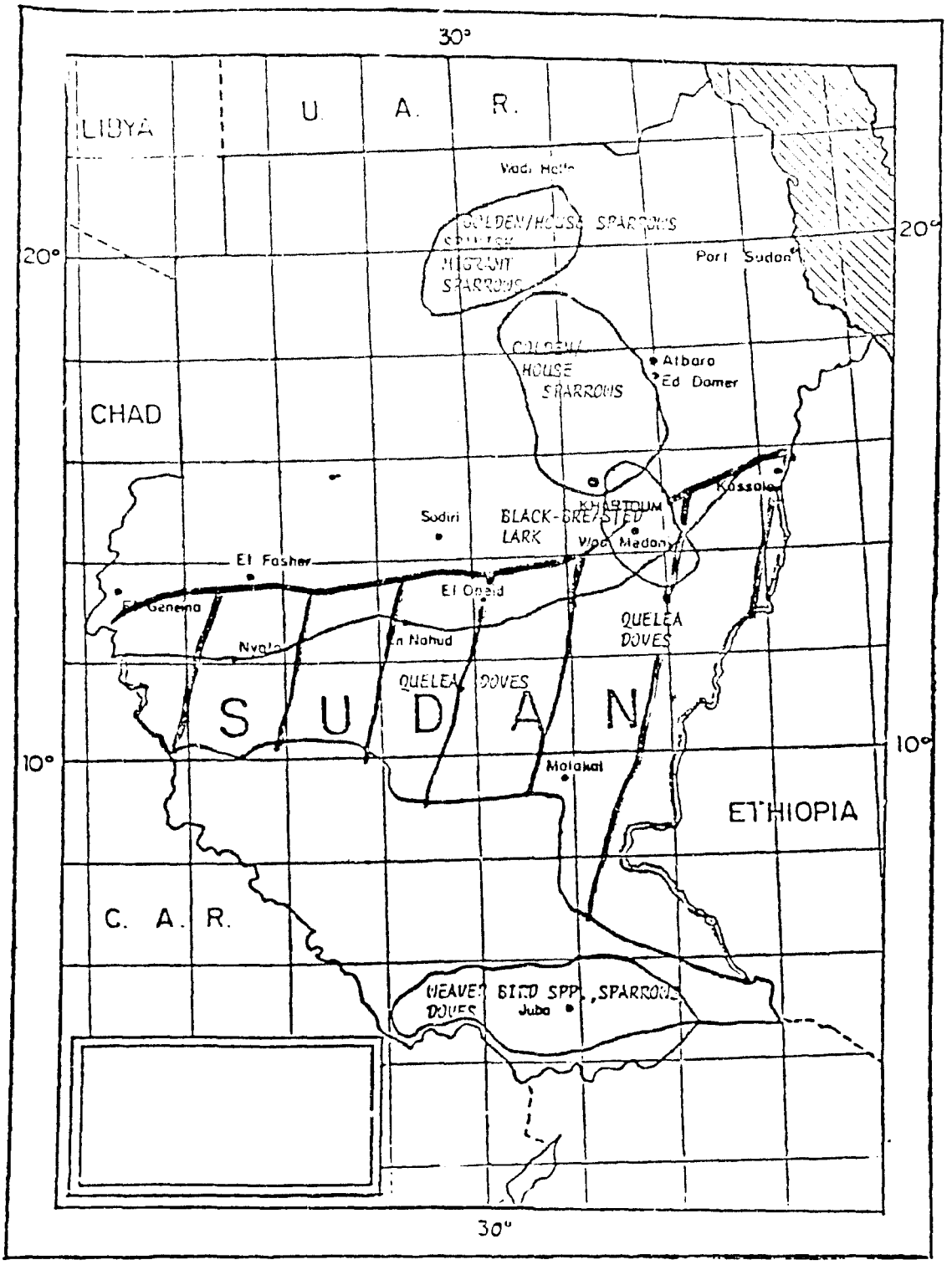


Fig. 1. Distribution of grain-eating birds in the Sudan.

Vertebrate Pest Research Project
USAID/DWRC/ARC
February 17, 1980

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Table 2. Control efforts at quelea nesting colonies and roosts, 1970-1978, by Plant Protection Department, Democratic Republic of the Sudan.

| Season | Number of nesting colonies | | Number of roosts | |
|---|---|---|---|---|
| | Located | Treated | Located | Treated |
| 1970/71 | 64 | 31 | 38 | 24 |
| 1971/72 | 52 | 34 | 38 | 23 |
| 1972/73 | 65 | 46 | 44 | 28 |
| 1973/74 | 58 | 44 | 39 | 23 |
| 1974/75 | 67 | 51 | 47 | 33 |
| 1975/76 | 77 | 57 | 41 | 28 |
| 1976/77 | 60 | 40 | 30 | 19 |
| 1977/78 | 150 | 150 | - | - |

## Some economic aspects

Recent investigations confirm the widely held belief that quelea are, indeed, the most destructive bird in the world. In cage studies in commercial fields near El Hawata on the Rahab River in Kassala Province, quelea were found to destroy about twice their weight in grain sorghum daily. In two days' time, 40 caged birds destroyed about 20 dabar sorghum heads, which should have produced about 150 g each. This test was replicated three times. This means that an individual 18-g quelea had the capability of destroying about 38 g of sorghum daily. At the current (November 1977) price of 37¢ U.S./kg for premium dabar sorghum, each quelea is capable of destroying about 43¢ U.S. worth of sorghum during an approximately 30-day nesting period. At this cost per bird, many methods of protecting crops or destroying quelea should prove economically feasible. For example, many simple methods, such as trapping, may be profitable. Sudanese personnel took more than 100 birds (fledglings) in a roost with two mist nets in less than 10 min. Small decoy traps have already been shown to be capable of taking large numbers of young quelea in nesting colonies. Trapping and netting in crop fields may also be profitable for quelea are very gregarious while feeding. In addition, it appears that the groups of 0.4- to 2-ha plots planted

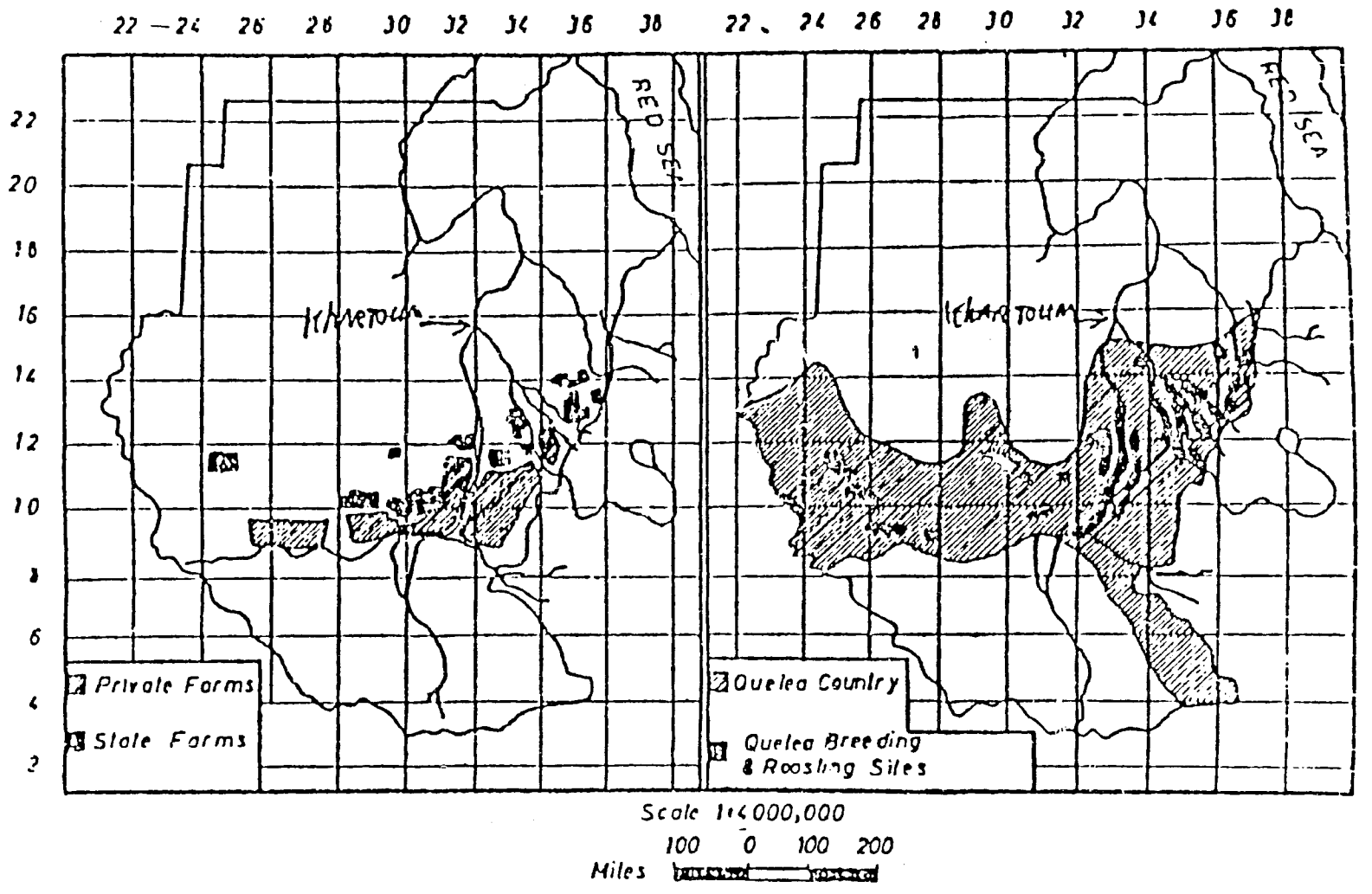


Fig. 2. Sorghum-growing area and quelea country in the Sudan (from Bashir, S. El and S. A. Bashir, undated). University of Khartoum, Plant Protection Department (MOA)

Table 2 summarizes the control efforts of the Sudanese Plant Protection Department for the years 1970-1978, and Table 3 indicates control efforts by this Department for 1979-1980.

Some economic aspects (Sudan)

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Spraying of breeding colonies in close proximity to croplands probably has a much higher cost:benefit ratio than previously suspected. A colony of a million breeding quelea has the capability of destroying 400 or more hectares of sorghum. Fenthion (the current chemical control agent of choice) is very hazardous to avian predators and should be replaced.

Quelea in breeding colonies in the Sudan feed very heavily on grain sorghum. Our Sudanese counterparts determined, through food habits studies at the El Hawata nesting colony, that 80 percent of the diet of adult and young quelea consisted of sorghum. This is in contrast to a study in Nigeria which found only 4 percent of the quelea diet was sorghum in a year of very heavy damage.

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|---|---|---|---|---|
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| 1973/74 | 58 | 44 | 39 | 23 |
| 1974/75 | 67 | 51 | 47 | 33 |
| 1975/76 | 77 | 57 | 41 | 28 |
| 1976/77 | 60 | 40 | 30 | 19 |
| 1977/78 | 150 | 150 | - | - |

Table 3.

Control Efforts at Nests and Roosts of Quelea and *Ploceus* spp. 1979-1980 by Plant Protection Department, Sudan[1/]

| Area Sprayed | Number of Feddans | Nest Colonies | | Number of Roosts | |
|---|---|---|---|---|---|
| | | Located | Treated | Located | Treated |
| Kosti | 1,767 | 10 | 10 | 1 | 1 |
| Gedarif | 2,610 | 10 | 10 | 3 | 3 |
| Sennar | 7,575 | 27 | 27 | -- | -- |
| Kadugli | 4,400 | 9 | 9 | -- | -- |
| Nyala | 2,731 | 14 | 14 | -- | -- |
| Total | 19,083 | 70 | 70 | 4 | 4 |

1/ Prepared by Ismail El Hag, PPD
February 10, 1980

Published data on crop losses to birds in Africa are scarce. Staff of the quelea research project are continually attempting to compile damage assessment statistics in order to provide a proper foundation for implementation of direct crop protection control programs. We have collected damage assessment information for the period 1965 to 1979 from literature, personal contacts, and field studies in Sudan, Kenya, and Tanzania. These are summarized below. Select damage assessment examples are noted in Table 4 and Table 5.

H. Schmutterer (Pests of Crops in Northeast and Central Africa) calculated that annual sorghum losses to red-billed quelea in Sudan amounted to a monetary loss of LS. 200,000 (Sudanese pounds) ($500,000).

Sadig Beshir, Head, Bird and Rodent Section, PPD, placed the estimate of annual losses of cereal crops to quelea in Sudan at 30 percent in 1977.

A 15-percent average annual loss on 3,000 feddans of sorghum in Umm Seinat, Kassala Province, was estimated by farmer Hassan Hamid. In 1976/77, a year of heavy quelea damage to sorghum, only 9,000 sacks of sorghum were harvested, instead of the usual rate of 15,000 sacks per year. This is a 40-percent loss valued at LS. 75,000 ($187,500) for that year. (Calculation at LS. 12.50 ($31.25) per sack.)

As reported by the Ministry of Agriculture, Food and Natural Resources, in 1975 at Abyei, South Kordofan Province, quelea were reported to have devastated the sorghum crop to such an extent that sorghum had

TABLE 4

PRELIMINARY ESTIMATES THROUGH 1979 OF BIRD DAMAGE TO AGRICULTURAL CROPS IN SUDAN AND OTHER AFRICAN COUNTRIES

| Species | Crops | Estimated Loss | Reference |
|---|---|---|---|
| SUDAN | | | |
| uelea sp. Red-billed Quelea) | Sorghum | LS 200,000 annually | Schmutterer, 1969 |
| uelea, others | Cereals | 30% average annual loss 1970 - 1974 | Beshir, 1976 |
| uelea | Sorghum, one farm (3000 feddans) | 40% (LS 75,000) Kassala Province | Bohl, 1978 |
| uelea | Sorghum, one farm (4,000 feddans) | 15% average, 1973 - 1976, Kassala Province | Bohl, 1978 |
| uelea | Sorghum, seed farm (12,000 feddans) | 150 feddans/one area destroyed, (LS 7,500) Kassala Province | Bohl, 1978 |
| uelea | Sorghum, one farm (6 study blocks) | 28-85%, (LS 6,250) Kassala Province | Besser, Bohl, 1978 |
| uelea | Sorghum, one farm (700 feddans) | 35-40%, Basunda, Kassala Province | Bruggers, Bohl, 1979 |
| uelea | Sorghum, Jebel Sim Sim Scheme (9,000 feddans) | 3-5% 1979; most farms received no damage | Bruggers, Bohl, 1979 |
| uelea, other | Millet 1,150,000 feddans; sorghum 609,219 feddans | 20% millet and sorghum 1977/78 Kordofan Province | El Gafar, F.A., PPD, El Obeid, 1979 (Report to FAO) |
| uelea | Millet | Upto 20-25%, Jodah, Upper Nile Province | Besser, Bohl, Ali,/PPD field trip, Nov. 1978 |
| uelea | Millet | 25-65% loss estimate 1974-76 Nyala, South Darfur Province | Plant Protection Dept., Nyala, 1978 |
| uelea, Doves | Sorghum, one farm (12,000 feddans) | 25% at beginning of harvest, 1979, Rahad River, Kassala Province | Bohl, 1979 |
| uelea, Doves | Sorghum (10-12,000 feddans annually, 1968-78) | 50-80% annually, 1968-78, Rahad River, Kassala Province | Mahgoub, Director, African Plantation Co. 1979 |

| Species | Crops | Estimated Loss | Reference |
|---|---|---|---|
| ETHIOPIA | | | |
| Quelea | Sorghum (lowlands) (75,000 hectares) | 10%, 18,870 M.T. Ethiopia | Jaeger, FAO 1978 |
| KENYA | | | |
| Quelea, Doves "Weavers", Starlings | Wheat, Rice, Millet Sorghum | $0.7 million 1952; 100,000 bags | Pearson 1967c DeGrazio 1973 DeGrazio & DeHaven 197 |
| Quelea | Wheat (30,000 ha.) | 10% 1975, 1976, Nakuru District | Ministry of Agriculture Kenya, 1976 |
| Quelea | Wheat, three large farms | 60-75%, Narok 1978 | Allan, FAO, 1979 |
| Quelea | Wheat, one farm (800 feddans) | 26-28% (LS 27,000) Nanyuki, 1978 | Bohl, 1979 |
| NIGERIA | | | |
| Quelea, Golden Sparrow, Starling, Doves "Weavers" | Rice, Wheat, Millet Sorghum, Corn | $2.8 million/year loss in one province | Pearson 1967c DeGrazio et al.1971, Ward and Jones 1977 |
| SENEGAL | | | |
| Quelea, Golden Sparrow, Ruff, "Weavers", Starlings, Doves | Rice, Sorghum, other grains | 100,000-200,000 tons of grain lost | Pearson 1967c DeGrazio 1972 Bruggers 1976 |
| SOUTH AFRICA | | | |
| Quelea | Cereals | $1.4 million loss of Sorghum in 1953 | Hey 1964, Pearson 1967a |
| SOMALIA | | | |
| Quelea, Golden Sparrow, Red Bishop, "Weavers" | Rice, Millet, Sorghum | $150/acre; heavy depredation on Rice | DeGrazio 1973 Holcomb 1976 Jackson 1978 |

| Species | Crops | Estimated Loss | Reference |
|---|---|---|---|
| TANZANIA | | | |
| Quelea | Lulu Millet, other cereals | 2,000 M.T., Singida Region | Daily Tanzanian News, 11/3/76 |
| Quelea | Wheat, government/ private farms (5-10,000 feddans) | 80-90%, 1978 West Kilimanjaro | Bohl, Bruggers, 1978 |
| Quelea | Wheat, one farm (2,500 feddans) | 86%, 1978 West Kilimanjaro | Bohl, Bruggers, 1979 |
| Quelea | Wheat (650 feddans) | 60%, 1978 Arusha Seed Farm | Ericsmoen, former USAID Seed Farm Manager, 1979 |

Vertebrate Pest Research Project

USAID/DWRC/ARC

Wayne H. Bohl - January 30, 1980

TABLE 5
PRELIMINARY FAO/UNDP CROP DAMAGE ASSESSMENT DATA
FROM CERTAIN EAST AFRICAN COUNTRIES[1/]

| | *Quelea q.* | Chestnut Weaver *Ploceus rubiginosus* | Golden Palm Weaver *P. bojeri* | Village Weaver *P. cuculatus* |
|---|---|---|---|---|
| No. cereal heads examined | 3,282 | 1,098 | 1,085 | 1,484 |
| Percent Eaten | | | | |
| Cereals | 15 | 62 | 13 | 63 |
| Sorghum | 48 | 42 | 14 | 22 |
| Maize | 0 | 48 | 56 | 78 |
| Rice | 26 | 0 | 0 | 5 |

1/ Unpublished research data collected by FAO scientists and country counterparts. Data presented November 12-17, 1979, First Workshop FAO/UNDP Grain-Eating Bird Pest Project, Arusha, Tanzania.

to be brought into the region from neighboring areas. A conservative estimate of this loss can be approximated from a figure of 14,000 sacks of sorghum, the amount a local trader stated merchants brought to Bahr el Ghazal Province in 1977 as their marketable surplus. The value of the crop lost at Abyei in 1975 would have been over $436,000. It is reported that quelea and "pigeons" (doves?) continue their depredations in this area, yet no population reduction measures at Abyei have been reported by PPD for past years.

Before the helicopter spray campaign of 1977 in the Nyala area in southern Darfur, annual losses of millet production to quelea were estimated between 30 to 75 percent by the Plant Protection Department.

In October 1976, PPD biologists collected data on sorghum losses at the State Seed Propagation Farm at Jebel Sim Sim, Kassala Province. The total production area was 12,000 feddans of various sorghum varieties. One 150-feddan area was completely destroyed by quelea; 200 additional feddans were slightly damaged. The 150 feddans had been expected to yield 600 sacks of sorghum, providing an income of LS 7,500 ($18,750). Quelea traveled from a breeding colony approximately 1 km from the seed propagation farm.

In October 1977, PPD and DWRC personnel conducted their first damage assessment study on approximately 100 feddans of premium Daber variety sorghum near El Hawata, Kassala Province, 5 km southeast of a quelea

nesting colony estimated to consist of over 1.5 million adult breeders. Nest trees contained an average of 250-300 nests each in an area of 40 to 50 feddans. Foraging flights of quelea at the study area averaged more than 3,000 birds/minute from nest colony to fields and return. Officers of the Mechanized Farming Corporation (M.F.C.) had reported about 110,000 feddans of six varieties of sorghum were raised in the El Hawata area. The most important variety to farmers, and the variety with the highest annual depredation by quelea, was the small-seeded white "Daber" variety.

The results of this study were reported in the 1977 annual report but are repeated here to illustrate the extent and severity of damage that can be caused by quelea.

1. Six study blocks were randomly selected and divided into 10 plots, each with 25 Daber heads, for a total of 1,500 heads.

2. Three of the six blocks were for reference and three for aerial treatment with methiocarb and an adhesive. These were sprayed on October 15, but the aerial spray was ineffective in preventing losses due to partially inoperative spray equipment, spray coming out under high pressure, and excessive heat and high winds. All of these factors combined to prevent the attainment of residue levels necessary to deter the birds. Consequently, the study ultimately became more significant as an exercise in damage assessment than for spray effectiveness.

3. Damage assessment readings on October 16, 1 day after spraying, showed a 6.3- to 10-percent loss in Blocks 1-4 and 4.5 percent for Blocks 5 and 6. Blocks 5 and 6 were just coming out of the tassel/flower stage; the heads had not matured to the more vulnerable milk stage of Blocks 1-4.

4. A second reading on October 23 showed an increase in damage as follows:

Block 1 - 73.16%
Block 2 - 78.31%
Block 3 - 73.94%
Block 4 - 72.67%
Block 5 - 51.40%
Block 6 - 32.58%

By November 15, losses were more than 95-98 percent in all six blocks. We concluded that at least five sacks of sorghum could have been produced per feddan. The resultant loss was valued at approximately

LS 6,250 ($15,625). Similar losses for many of the remaining farms of the 110,000 feddans would have amounted to a considerable monetary loss.

Figure 3.
Quelea damage small-grain crops and adversely affect the agricultural economies of some twenty nations in Africa. The extent of damage they can cause is graphically illustrated in this photograph; the center stalk of millet is undamaged but the other two have been completely stripped of seed.

The following information was extracted from a "Trip Report Sudan and East Africa", pp. 4 - 5, undertaken October 21 - 25, 1979 by Richard Bruggers and Wayne H. Bohl, U.S. Fish and Wildlife Service, Denver Wildlife Research Center, Wildlife Research Biologists and Plant Protection Department counterparts.

"Sudan--Survey south of Gedarif-Jebel Sim Sim and Basunda sorghum production and Quelea nesting areas

"Damage: Due to reduced and late rainfall in September in 1979, Quelea were not present in their normal range along the White Nile and near the Migreh Mountains between Wad Medani and Gedarif. We were, therefore, unable to conduct the planned Shamba repellent field trials. Further southeast, in the large sorghum schemes around Jebel Sim Sim, about 10 Quelea nesting colonies were located and sprayed by the Ministry of Agriculture, Plant Protection Department (PPD). We visited one successfully-treated colony at Basunda on October 23 in which many dead or dying birds were observed, few adults returned to feed young, and no birds were seen in adjacent sorghum fields. The colony was reported to be 2 x 4 km. in area. Damage was heavy in some of the fields surrounding this colony and minor in others (Table 1).

" Table 1. Damage to cereal crops in Sudan observed during October 21 - 25, 1979, survey trip. Fields were randomly selected along the road or in the large schemes, and traversed in a regular, random manner, with five consecutive heads observed at each interval.

| Location | Crop | Approximate area sampled (ha) | Average % damage | Bird Species |
|---|---|---|---|---|
| Migreh Mountains | Sorghum | 5 | 0 | None |
| Gedarif | Sorghum | 3 | 0 | None |
| Jebel Sim Sim* | Sorghum | 5 | 3-5 | Quelea |
| Basunda | Sorghum | 15 | 35-40 | Quelea |
| Wad Medani | Rice | 10 | 0 | None |
| Khartoum-ARC | Maize | 2 x 0.1 | 5-10 | Ploceus |
| | Sorghum | 0.1 | 100 | Ploceus |
| | | | | Quelea |
| | | | | Sparrows |
| | Millet | 0.1 | 100 | Bishops |

* Farms on the 9,000-feddan Jebel Sim Sim scheme, most of which received no damage.

"Food Habits: The crop contents of 100 Quelea collected from a nesting colony at Jebel Sim Sim were analyzed. Seventy-six percent of the birds had eaten sorghum although only 16% ate it exclusively. Most birds ate both sorghum and wild seeds. Insects were not an important part of the diet.

"Collection: Three hundred Quelea were collected, separated by sex, and returned to Khartoum to await shipment to DWRC in February 1980 for laboratory work."

Damage assessment surveys were conducted by DWRC/PPD personnel in January-February 1978 and 1979 on the Managil area, Southern Gezira. Interviews with numerous farmers and random sampling of fields, collecting 100 heads along two-foot strips, disclosed insignificant bird damage. No quelea occupy this wheat area of 400,000 to 500,000 feddans of cropland.

Further north in Sudan, from Wad Medani to Khartoum, Damer and Dongola, the golden sparrow, house sparrow, bishops and Spanish migrant sparrow attack wheat plantings significantly, often necessitating the planting of less susceptible cereal crops such as barley or corn. Corn is attacked by larger weaver birds of the genus Ploceus spp. Laboratory and field research studies are contemplated for the 1980 and 1981 seasons at the ARC Shambat field station to repel these voracious bird pests.

Depredation by quelea, and weaver birds of the genera Ploceus spp. and Euplectus on rice are not significant in Sudan, in part because of the isolation of these smaller acreages and because these birds find little suitable habitat in close vicinity to the rice schemes. At the ten-feddan rice seed farm at ARC in Wad Medani, quelea, house sparrows and golden sparrows are said to have destroyed freshly planted seed as well as rice seedlings at a rate of 15 to 20 percent annually, according to Dr. George Ghobrial, ARC Rice Seed Researcher. DWRC has received approval from Dr. Ghobrial to do a damage assessment replicate study in early June 1980 at the rice planting then. Rice seed will have a dressing of methiocarb applied before sowing.

Table 5. Summary of major bird damage problems in the Sudan. (Prepared by Biologist Babiker Ali, PPD.)

| Province | Potential damage areas | Crops affected | Crop phenology | | | Preferred stage | Major species[a] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Sowing | Milk stage | Harvest | | | |
| Kassala | Hawata | Sorghum | Late Jul | Late Sep/Oct | Jan-Feb | Milk | Quelea | Sorghum grown throughout Province. Millet grown limited scale --Hawata. Sesame grown in southern region. Sowing dates dependent on rains. Damage occurs in all stages. |
| | Sim Sim | Millet | Late Jul | Late Sep/Oct | Jan-Feb | Hard | Doves | |
| | Um Senat | Sesame | Late Jul | Sep | Nov | Milk | Ploceids | |
| | Megrih Mtns. | | | | | | | |
| Blue Nile | Sennar District | Sorghum | Late Jul | Late Oct | Jan-Feb | Milk | Quelea | Irrigated sorghum at Agr. Research Corp. Millet grown on limited scale. Damage occurs in all stages. |
| | | Millet | Late Jul | Late Oct | Jan-Feb | Hard | Doves | |
| | | | | | | Milk | Ploceids | |
| White Nile | Kosti | Sorghum | Jul | Oct | Dec-Jan | Milk | Quelea | Damage occurs in all stages. |
| | Renk | Millet | Jul | Oct | Dec-Jan | Hard | Doves | |
| | Meginus | Sesame | Jul | Late Sep | Nov-Dec | Milk | Ploceids | |
| Southern Darfur | Nyala | Millet | Late May | Jul | Sep | Milk | Quelea | Damage occurs in all stages. |
| Southern Kordofan | Kadugli | Millet | Late May | Jul | Sep | Milk | Quelea | Damage occurs in all stages. |

## Basis for estimates of cereal grain losses to quelea in Africa

Crook and Ward (The Problems of Birds as Pests) estimate the continental population of quelea to be between $10^9$ and $10^{11}$ individuals and suggest that 90-100 percent of the quelea diet is comprised of the seeds of wild grasses. Laboratory studies indicate the average food consumption of quelea approximates 3 g/day. If we use the lower estimate of $10^9$ individuals and assume that 10 percent of the food consumption of the entire bird population during a 30-day period each year, when mature grains are present, accounts for total damage, the total amount of grain consumed by this population is 90,000 metric tons per year. Conservatively assuming a field value to small farmers of $100 per metric ton, the value of this loss amounts to $9 million. If we use the estimate of $10^{11}$ for the quelea population and make the same assumptions, the result is a calculated annual loss of $900 million. Statements of losses as "more than $100 million per year" are based on a midpoint population estimate and a recognition of the conservative figures used in these assumptions.

## Summmary of major bird damage problems in the Sudan

A summary of the major bird damage problems in the Sudan is given in Table 6.

**Table 6. SUMMARY OF MAJOR BIRD DAMAGE PROBLEMS IN THE SUDAN**

| Province | Potential Damage Areas | Crops Affected | Crop Phenology: Sowing | Crop Phenology: Milk Stage | Crop Phenology: Harvest | Preferred Stage | Major Species* | Remarks |
|---|---|---|---|---|---|---|---|---|
| Kassala | Hawata<br>Sim Sim<br>Um Senat<br>Rojeik Mtns. | Sorghum<br>Millet<br>Sesame | Late July<br>Late July<br>Late July | Late Sept/Oct.<br>Late Sept/Oct.<br>September | Jan.-Feb.<br>Jan.-Feb.<br>November | Milk<br>Hard<br>Milk | Quelea<br>Doves<br>Ploceids | Sorghum grown throughout Provinc<br>Millet grown limited scale-Hawat<br>Sesame grown in southern region.<br>Sowing dates dependent on rains.<br>Damage occurs in all stages. |
| Blue Nile | Sennar District | Sorghum<br>Millet | Late July<br>Late July | Late Oct.<br>Late Oct. | Jan.-Feb.<br>Jan.-Feb. | Milk<br>Hard<br>Milk | Quelea<br>Doves<br>Ploceids | Irrigated sorghum at Agr. Research Corp.<br>Millet grown on limited scale.<br>Damage occurs in all stages. |
| White Nile | Kosti<br>Penk<br>Reginus | Sorghum<br>Millet<br>Sesame | July<br>July<br>July | October<br>October<br>Late Sept. | Dec.-Jan.<br>Dec.-Jan.<br>Nov.-Dec. | Milk<br>Hard<br>Milk | Quelea<br>Doves<br>Ploceids | Damage occurs in all stages. |
| Southern Darfur | Nyala | Millet | Late May | July | September | Milk | Quelea | Damage occurs in all stages |
| Southern Kordofan | Kadugli | Millet | Late May | July | September | Milk | Quelea | Damage occurs in all stages. |
| Northern Province | Dongola | Sorghum<br>Wheat<br>Fruits<br><br>Vegetables<br>Alfalfa | Rainy seasons<br>Late Nov.<br>March<br><br>Varies<br>All year | January | Feb.-March | Milk<br>Milk<br>Flowering & Fruit<br>Ripe<br>Flowering | Golden and House Sparrows | Damage occurs in all stages on sorghum and wheat. |
| Nile Province | Ed Damer | Wheat<br>Vicia fulva<br>Sorghum<br>Palm dates<br><br>Fruits | Late Nov.<br>Late Nov.<br>Rainy season<br>February | Jan. (?)<br>Jan. (?) | Feb.-Mar.(?)<br>Feb.-Mar.(?) | Milk<br>Flowering<br>Milk<br>Flowering & Fruit<br>" " | Golden and House Sparrows | Damage occurs in all stages on sorghum and wheat. |

* Doves are becoming a more serious pest

Prepared by: Biologist Habiber Ali, PPD

Estimates of economic losses for certain East African countries through 1979

In 1964 the Food and Agricultural Organization (FAO) of the United Nations calculated that there was an $8.5 million annual loss due to quelea damage in small grains in Africa. A more up-to-date description of bird pest depredation was presented by John De Grazio (1978) in a paper titled "World Bird Damage Problems" presented at the Eighth Vertebrate Pest Conference in California. Some of the outstanding economic losses of African grain crops to the red-billed quelea and other species cited in this report include:

- $ 0.5 million loss annually of grain sorghum
- $0.7 million loss to cereal crops in Kenya in 1952
- $2.8 million lost in one province in Nigeria in one year
- 100,000 to 200,000 tons of cereal lost annually in Senegal
- a $150/0.4 ha loss in Somalia
- in South Africa a $1.5 million loss in sorghum alone

In a final USAID/Kenya report, "Kenya Marginal/Semi-Arid Lands Preinvestment Study", the authors, Drs. Herbert O. Mann and I.D.R. Kariuki, note the following, in speaking of bird pests of cereal grains:

"Sorghum:

"Birds: These are without doubt one of the main causes of crop loss in sorghum. Bird susceptible varieties sometimes are completely destroyed. Of the birds that attack sorghum, the Sudan Dioch, *Quelea quelea aethiopica*, is the most devastating. Others are sparrows, yellow weavers, bishop birds, doves, parrots, crows and buntings.

The bird hazard causes a tendency to plant maize where sorghum is actually better adapted to soil and moisture conditions. Resistant varieties have tannin in the seed coat or just under the seed coat. These are not readily eaten by birds or people. Goose necked varieties are slightly resistant, as are varieties with loose panicles, large glumes or prominent awns. Quelea control units kill large numbers of birds by various methods."

Table 7 gives information on the major bird pest species in East Africa, information compiled at a FAO/UNDP workshop in Arusha, Tanzania in November 1979.

During a July 1979 field trip in Kenya, Biologist Bonl in company with Richard Allan, FAO scientist, visited the 800-acre wheat farm of Mr. George Murray near Nanyuki and obtained the following damage information. Damage by quelea, chestnut weaver, and paradise and brown whydahs was reported heave in 1974-1978 from isolated fields averaging 120-150 acres each. Without bird damage the wheat production averages 15 sacks per acre. In 1978 it was determined that approximately four sacks per acre were lost to quelea, with a million or more birds present that year on migration through the area. This was a loss of 3,200 sacks (90 kilograms each) that would have brought $54,400 on the local market, or 26.6% of the anticipated annual production.

Only small numbers of quelea were noted in 1979; about 25 percent of the croplands were planted to wheat. Rainfall was heavy resulting in widespread grasses that would provide the normal wild feed for quelea. It is thought that large acreages of wheat will be planted in 1980 to make up for the deficit production in 1979 and that quelea damage

Table 7.

**Major Bird Pest Species in East Africa**

(Data prepared by FAO/UNDP for November 1979 Workshop, Arusha, Tanzania

| Countries | *Quelea q.* | *Ploceus* spp. | | *Streptopelia* spp. | Cereals Most Damaged |
|---|---|---|---|---|---|
| | | *P. cuculatus* | *P. rubiginosus* | | |
| Ethiopia | XXX | XX | XX | * | Wheat, sorghum |
| Kenya | XXX | XX | X | * | Wheat, sorghum, rice, millet |
| Somalia | XXX | XX | X | * | Wheat, sorghum, rice, maize |
| Sudan | XXX | XX | * | X | Sorghum, millet |
| Tanzania | XXX | * | XX | X | Wheat, sorghum, millet |

Ranking = XXX - serious pest
XX - intermediate pest
X - minor pest
* - occur, but not reported as pest

could approximate the rates in 1974 through 1978.

In other areas of Kenya, as well as Tanzania, reports by FAO staff and farmers in 1978 and 1979 indicate the following. Heavy quelea depredations occurred in 1978 in both countries, particularly on wheat, rice, sorghum and millet. At Narok, in western Kenya, quelea were responsible for 65 to 85 percent losses to wheat on three very large farms. Nanyuki experienced losses from 25 to 75 percent, with other local losses often exceeding 75 percent.

In August 1979 at West Kilimanjaro, Tanzania, a spot-spraying technique on 3,000 acres of wheat, with a quelea population present estimated at 20,000 birds, might have resulted in a yield of six bags/acre (90 kg/bag) compared to a 1978 yield of only 1.4 bags/acre, calculated as an 84% loss when the spot-spraying method was not used. (FAO Trip Report, Richard Bruggers). The results of this spot spraying have left some puzzling questions on quelea feeding behavior and point out the complexity of the problem when dealing with quelea populations at croplands.

Nearby Tanzanian government farms on West Kilimanjaro this same year suffered 80 to 90 percent wheat losses. In the Ngorongoro Crater wheat growing area, quelea destroyed an estimated 50 to 60 percent in some fields.

Current quelea damage estimates from Ethiopia were furnished by FAO ornithologist M. Jaeger. Samples on 75,000 hectares showed an

estimated loss of 18,870 M.T. This represented one-tenth of the total production. Similar losses, Jaeger reports, occur throughout East Africa. In Ethiopia queleas represent the most important of the vertebrate depredators of standing cereals, especially lowland sorghum.

Discussion of cost benefit ratios concerning quelea cereal crop depredation in Sudan

During each breeding season in Sudan, September-October, or on the line of migration after nesting, quelea may attack cereal crops in large to vast numbers (Wilson, 1947). Milk/dough stages are preferred and crops can be destroyed within a few days or sometimes even hours (Schmutterer, 1969).

A single quelea is able to eat about 3-4 g of grain a day, but much more than this is wasted and falls to the ground. Doggett (1970) notes the following in his Sorghum book under the "General Bird Problem":

"The Quelea are wasteful feeders on larger grains such as rice and sorghum, they peck the germ out of the soft green grain, and most of the remainder is dropped in pieces on the ground. Each bird may damage up to 50 gm per day in this way (Haylock, 1960), while an estimate of the daily consumption of 20 gm has been made in West Africa (Pradat, 1962). Assuming that fifty birds consume or damage one kilogram of grain per day, then the daily consumption of one million birds is about 20 tons of grain. Allowing that they feed for thirty days of each year in the crops, and that the population of all three races of

Quelea in Africa is about 1,000 million birds (which must surely have been the case in some years of the 1950 decade) then the grain loss to Africa caused by these birds is of the order of 600,000 tons annually. This is a low estimate, the figure could well be over one million tons."

DWRC biologists and PPD counterparts found during quelea field and cage studies at Hawata, Kassala Province in October 1977 that a breeding colony of a million birds has the capability of destroying 400 or more hectares of sorghum in a 30-day period. Further, 40 caged birds in two days' time destroyed about 20 Daber sorghum heads, which should have produced about 150 g each. This test was replicated three times. This means that an individual 18 g quelea had the capability of destroying about 38 g of sorghum daily. At the November 1977 price of 37¢/kg for premium Daber sorghum, each quelea was capable of destroying about 43¢ worth of sorghum during an approximate 30-day nesting period.

Estimates of percentage losses to sorghum crops in the Sudan are noted in Table 4. Of the 13 entries of estimated loss it is believed by the project leader that five can reasonably be considered at this time as a preliminary indication of the magnitude of national losses annually attributable to quelea. Percentage losses for sorghum noted include 30% average annual losses for 1970-1974 to quelea and other birds (Beshir, 1976); 15% average annual losses, 1973-1976, quelea (Bohl, 1978); 20% sorghum and millet loss to quelea and others in 1977/78 (El Gafar, 1979); and 50-80% annually, 1968-1978, to quelea and doves (Mahgoub, 1979).

Arbitrarily, we can assume from these percentage ranges that quelea cause losses annually to sorghum and millet in Sudan ranging from a low of 15% to 20% to the extreme of 50 to 80%. Production and average yield by province are given in Tables 8 through 13. Prime habitat of quelea and doves is noted by an asterisk. By taking the production figures representing metric tons (M.T.) and the provinces marked by asterisks it is possible to project percentage losses in metric tons followed by calculations of the loss in Sudanese pounds or U.S. dollar.

Assuming a 15% to 20% annual loss of sorghum and millet from the provinces marked with an asterick, the following losses to quelea are suggested for the years 1975/76 when the production totaled 1,907,840 M.T. A fifteen percent loss factor equals 286,176 M.T. or $ 28,617 million and a twenty percent loss would equal 381,568 M.T., or $ 38,156 million.

Table 8

Sudan Sorghum (Duhra): Area, Production and Average Yield 1974/75 (final) and 1975/76.[1]

| Production Centre | 1974/75 | | | 1975/76 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (m.t.) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (m.t.) | Aver. Yield (Kg/f.) |
| Northern Province | 18,950 | 9,300 | 490 | 18,000 | 6,000 | 333 |
| Nile Province* | 68,030 | 29,795 | 438 | 51,000 | 21,420 | 420 |
| Khartoum Province | 24,500 | 2,850 | 116 | 10,000 | 1,500 | 150 |
| Gedarif* | 1,635,000 | 561,000 | 343 | 1,996,100 | 702,600 | 352 |
| Gash | 43,000 | 16,250 | 378 | 50,000 | 12,500 | 250 |
| Tokar | 40,000 | 14,280 | 357 | 56,000 | 16,800 | 300 |
| Gezira & Managil | 154,500 | 77,050 | 500 | 341,257 | 238,700 | 700 |
| Gezira (Traditional) | 98,000 | 19,600 | 200 | 90,000 | 22,500 | 250 |
| Blue Nile (Trad.)* | 360,000 | 108,000 | 300 | 535,000 | 105,400 | 310 |
| Blue Nile (Mech.)* | 695,850 | 184,176 | 265 | 500,000 | 153,000 | 327 |
| Blue Nile (Irrig.)* | 55,000 | 19,800 | 360 | 55,500 | 19,420 | 350 |
| White Nile (Trad.)* | 127,000 | 47,625 | 375 | 288,000 | 86,400 | 300 |
| White Nile (Mech.)* | 48,400 | 22,000 | 454 | 70,000 | 24,500 | 350 |
| White Nile (Irrig.)* | 74,000 | 32,200 | 435 | 68,400 | 27,900 | 400 |
| South Kordofan (Mech.)* | 160,490 | 59,040 | 367 | 182,440 | 69,330 | 380 |
| S. Kordofan (Nuba Mt.)* | 391,000 | 137,000 | 350 | 346,000 | 93,420 | 270 |
| S. Kordofan (Sands)* | 80,000 | 16,000 | 200 | 80,000 | 20,000 | 250 |
| North Kordofan* | 347,000 | 52,050 | 150 | 329,000 | 53,960 | 164 |
| South Darfur (Mech.)* | 4,470 | 1,800 | 179 | 6,710 | 2,000 | 300 |
| South Darfur (Trad.)* | 252,000 | 63,000 | 250 | 338,150 | 88,940 | 263 |
| North Darfur* | 50,000 | 12,500 | 250 | 40,000 | 8,000 | 200 |
| Upper Nile (Mech.)* | 226,000 | 85,000 | 375 | 312,500 | 118,750 | 380 |
| Upper Nile (Trad.)* | 209,000 | 43,262 | 207 | 200,000 | 42,000 | 210 |
| Bahr El Ghazal* | 196,000 | 31,000 | 158 | 200,000 | 32,000 | 160 |
| Equatoria* | 218,840 | 57,000 | 260 | 210,000 | 58,800 | 280 |
| TOTAL SUDAN | 5,577,030 | 1,701,578 | 306 | 6,179,057 | 2,025,840 | 327 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* Quelea, other weaver birds, Doves, Sparrows habitat for nesting and roosting.

Table 9
**Sudan Sorghum (Duhra): Area Production and Average Yield, 1976/77 (final)[1]**

| Production Centre | Total Area (Feddans) | Total Production (m.t.) | Aver. Yield (Kg/f.) |
|---|---|---|---|
| South Kordofan Province* | 17,200 | 3,400 | 198 |
| Nuba Mt. | | | |
| North Kordofan Province* | 1,353,000 | 196,000 | 145 |
| South Darfur Province* | 650,000 | 130,000 | 200 |
| North Darfur Province* | 522,000 | 88,000 | 170 |
| Bahr El Ghazal Province* | 70,000 | 14,000 | 200 |
| Equatoria Province* | 2,000 | 300 | 150 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* Quelea, other weaver birds, Doves, Sparrows habitat for nesting and roosting.

Table 9

**Sudan Sorghum (Duhra): Area Production and Average Yield, 1976/77 (final)[1]**

| Production Centre | Total Area (Feddans) | Total Production (m.t.) | Aver. Yield (Kg/f.) |
|---|---|---|---|
| South Kordofan Province* Nuba Mt. | 17,200 | 3,400 | 198 |
| North Kordofan Province* | 1,353,000 | 196,000 | 145 |
| South Darfur Province* | 650,000 | 130,000 | 200 |
| North Darfur Province* | 522,000 | 88,000 | 170 |
| Bahr El Ghazal Province* | 70,000 | 14,000 | 200 |
| Equatoria Province* | 2,000 | 300 | 150 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* Quelea, other weaver birds, Doves, Sparrows habitat for nesting and roosting.

Table 10.
Sorghum
Rainfed Traditional Sector For Sudan[1]

| Region of Production | 1977/78 | | | 1978/79 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
| Gezira Province | 225,000 | 32,000 | 140 | 260,000 | 154,000 | 400 |
| Blue Nile Province | 455,000 | 125,000 | 275 | 683,000 | 225,000 | 329 |
| White Nile Province | 270,000 | 40,000 | 148 | 200,000 | 60,000 | 300 |
| Southern Kordofan Province | 280,000 | 90,000 | 321 | 385,000 | 132,000 | 343 |
| Northern Kordofan Province | 650,000 | 180,000 | 277 | 600,000 | 180,000 | 300 |
| Southern Darfur Province | 375,000 | 160,000 | 427 | 400,000 | 120,000 | 300 |
| Northern Darfur Province | 52,000 | 76,000 | 135 | 52,000 | 10,000 | 192 |
| Southern Region | 729,000 | 179,000 | 245 | 730,000 | 180,000 | 246 |
| Total Rainfed Agriculture | 3,036,000 | 813,000 | 276 | 2,310,000 | 1,011,000 | 204 |
| Total Quantity | 6,662,000 | 2,017,000 | 303 | 7,202,000 | 2,408,000 | 334 |

[1] Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

Table 11.
Preliminary Assesments
Area and Quantity of Duhra (Sorghum) Production in the Sudan
For 1978/79 Caompared with 1977/78 Season[1]

| Region of Production | 1977/78 | | | 1978/79 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
| A- Irrigated Agriculture: | | | | | | |
| Northern Province | 15,000 | 6,000 | 400 | 15,000 | 6,000 | 400 |
| Nile Province | 30,000 | 12,000 | 400 | 35,000 | 14,000 | 400 |
| Kassala (EL GASH) | 32,000 | 8,000 | 200 | 24,000 | 7,000 | 292 |
| Kassala (New Halfa) | - | - | - | 8,000 | 3,000 | 375 |
| Red Sea (Toker) | 28,000 | 14,000 | 500 | 64,000 | | |
| Gezira and Managil | 353,000 | 190,000 | 538 | 344,000 | | 491 |
| Blue Nile | 50,000 | 25,000 | 500 | 57,000 | 30,000 | 526 |
| White Nile (Dueim) | 24,000 | 11,000 | 460 | 33,000 | 15,000 | 455 |
| White Nile (Kosti) | 7,000 | 2,000 | 286 | 11,000 | 5,000 | 455 |
| Total of Irrigated Agriculture | 539,000 | 268,000 | 497 | 591,000 | 281,000 | 476 |
| B- Rainfed Modern Sector | | | | | | |
| Khartoum Province | 17,000 | | 118 | 18,000 | 4,000 | 222 |
| Kassala (Gedarif) | 1,848,000 | 554,000 | 300 | 2,076,000 | 725,000 | 349 |
| Blue Nile (Damazin) | 507,000 | 168,000 | 320 | 502,000 | 175,000 | 349 |
| White Nile (Elmiganis) | 125,000 | | 280 | 150,000 | 45,000 | 300 |
| Southern Kordofan (Mechanized) | 295,000 | 80,000 | 270 | 227,000 | 68,000 | 300 |
| Southern Kordofan (Modernized) | 24,000 | 9,000 | 360 | 4,000 | 1,000 | 250 |
| Southern Darfur | 6,000 | 2,000 | 300 | 10,000 | 3,000 | 300 |
| Southern Region | 265,000 | 92,000 | 347 | 314,000 | 15,000 | 303 |
| Total Rainfed Agriculture Modern Sector | 3,087,000 | 936,000 | 303 | 3,301,000 | 1,116,000 | 338 |

[1] Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

Table 12

Millet (Dukun): Area, Production & Average Yield for Sudan 1974/75 (Final) & 1975/76 (Provisional)[1]

| Production Centre | 1974/75 | | | 1975/76 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (M.T.) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (M.T.) | Aver. Yield (Kg/f.) |
| Gedarif | 2,100 | 420 | 200 | 7,200 | 1,585 | 220 |
| Blue Nile (Trad.)* | 39,920 | 9,980 | 250 | 45,000 | 10,800 | 240 |
| Gezira (Trad.) | 2,000 | 300 | 150 | 2,500 | 400 | 160 |
| White Nile (Trad.)* | 41,040 | 5,650 | 138 | 82,800 | 17,940 | 217 |
| S. Kordofan (Nuba Mt.)* | 39,300 | 10,000 | 255 | 35,680 | 8,560 | 240 |
| S. Kordofan (Sands)* | 35,000 | 8,050 | 230 | 31,000 | 6,665 | 215 |
| N. Kordofan Sands* | 1,250,000 | 112,500 | 90 | 1,257,000 | 125,700 | 100 |
| South Darfur (Mech.)* | - | - | - | 7,200 | 1,150 | 160 |
| South Darfur (Trad.)* | 530,000 | 121,900 | 230 | 438,780 | 126,945 | 289 |
| North Darfur* | 570,000 | 118,000 | 207 | 530,000 | 88,500 | 167 |
| Bahr El Ghazal* | 63,000 | 13,020 | 205 | 70,000 | 14,000 | 200 |
| Upper Nile | - | - | - | - | - | - |
| Equatoria* | 4,020 | 720 | 180 | 5,000 | 900 | 180 |
| Total Sudan | 2,576,380 | 400,540 | 156 | 2,512,160 | 403,145 | 161 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* Quelea, other weaver birds, Doves, Sparrows habitat for nesting and roosting.

Table 13

Preliminary Assessment For Sudan,
Area and Quantity of Millet Production
For 1978/79 Compared with 1977/78 Season[1]

| Region of Production | 1977/78 | | | 1978/79 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
| Red Sea Province | 22,000 | 9,000 | - | - | - | - |
| Kassala (Gedarif) | 5,000 | 1,000 | ? | 5,000 | 1,000 | 200 |
| Blue Nile (Traditional) | 44,000 | 6,000 | 140 | 60,000 | 10,000 | 167 |
| White Nile (Traditional) | 54,000 | 11,000 | 250 | 135,000 | 27,000 | 200 |
| El Gezira (Traditional) | 5,000 | 1,000 | 200 | 6,000 | 1,000 | 170 |
| Southern Kordofan (Trad.) | 90,000 | 18,000 | 200 | 40,000 | 9,000 | 225 |
| Northern Kordofan (Trad.) | 1,150,000 | 150,000 | 130 | 1,050,000 | 210,000 | 156 |
| Southern Darfur (Trad.) | 975,000 | 191,000 | 196 | 985,000 | 197,000 | 200 |
| Northern Darfur (Trad.) | 30,000 | 91,000 | 172 | 502,000 | 90,000 | 180 |
| Southern Region (Trad.) | 73,000 | 10,000 | 140 | 75,000 | 12,000 | 160 |
| Total | 2,984,000 | 488,000 | 166 | 3,158,000 | 557,000 | 177 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

Table 14

Sudan Preliminary Assessment

Area and Quantity of Rice Production

For 1978/79 Compared with 1977/78 Season[1]

| Region of Production | 1978/79 | | | 1977/78 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
| Gezira Scheme* | 10,000 | 8,000 | 755 | 4,025 | 5,000 | 1,742 |
| Southern Region* | 5,400 | 1,000 | 185 | 5,500 | 1,000 | 182 |
| Total | 16,000 | 9,000 | 365 | 9,525 | 6,000 | 60 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* In particular, attacked by weaver birds and sparrows.

Table 15

Preliminary Assessments for Sudan

Area and Quantity of Wheat Production

For 1978/79 Compared with 1977/78[1]

| Region of Production | 1977/78 | | | 1978/79 | | |
|---|---|---|---|---|---|---|
| | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
| Gezira and Managil | 465,000 | 260,000 | 559 | 503,000 | 226,000 | 300 |
| New Halfa | 80,000 | 28,000 | 350 | 51,000 | 18,000 | 250 |
| El Rahad | 10,000 | 7,000 | 700 | 5,000 | 3,000 | 500 |
| Duiem | 5,000 | 1,000 | 200 | - | - | - |
| Kosti | 6,000 | 2,000 | 330 | - | - | - |
| Nile Province | 6,000 | 3,000 | 500 | 5,000 | 3,000 | 600 |
| Northern Province | 29,000 | 16,000 | 550 | 25,000 | 16,000 | 460 |
| Khartoum Province | 1,000 | 2,000 | 200 | 1,000 | 200 | 200 |
| Total | 592,000 | 317,000 | 338 | 590,000 | 266,200 | 451 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

Table 16

Preliminary Assessment for Sudan

Area and Quantity of Corn - Maize Production

For 1978/79 Compared with 1977/78 Season[1]

| Region of Production | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) | Area (Feddans) | Production (Ton) | Aver. Yield (Kg/f.) |
|---|---|---|---|---|---|---|
| Northern Province | 1,000 | 400 | 400 | 1,000 | 400 | 500 |
| Nile Province* | 1,000 | 400 | 400 | 1,000 | 400 | 500 |
| Blue Nile Province* | 30,000 | 6,000 | 200 | 41,000 | 12,000 | 612 |
| White Nile Province* | 1,000 | 200 | 200 | 1,000 | 200 | - |
| Southern Kordofan Province* | 15,000 | 3,000 | 200 | 11,000 | 3,000 | 273 |
| Southern Region* | 91,000 | 33,000 | 363 | 90,000 | 30,000 | 300 |
| Total | 139,000 | 43,000 | 308 | 145,000 | 46,000 | 319 |

[1] Adapted from table from Ministry of Agriculture, Food and Natural Resources, Agricultural Economics Administration, Agricultural Statistics Division.

* In particular attacked by weaver birds of the genus *Ploceus* spp.

Table 17 Bird damage problems in Kenya, Quelea Control Unit, Ministry of Agriculture (DWRC 1973 Annual Report)

| SPECIES | CROP AFFECTED | STAGE | TIME PERIOD | AREA |
|---|---|---|---|---|
| Quelea quelea aethiopiea (Sudan Dioch) | Wheat | Milk | December - January and April - August | Rift Valley and Central Provinces |
| | Sorghum | Milk | January - March | Eastern Province |
| | Bulrush Millet | Any stage | January - March | Eastern and Central Provinces |
| | Finger Millet | Any stage | January - March and April - August | Eastern, Rift Valley, Nyanza, and Western Provinces |
| | Rice | Milk | Year-round | In respective schemes in Northern, Western, Central, and Coast Provinces |
| Chestnut Weaver | Wheat | Any stage | December - January and April - August | Rift Valley and Central Provinces |
| | Sorghum | Any stage | January - March | Eastern Province |
| | Bulrush Millet | Any stage | January - March | Eastern and Central Provinces |
| | Finger Millet | Any stage | January - March and April - August | Eastern, Rift Valley, Nyanza, and Western Provinces |
| | Rice | Any stage | Year-round | In repsective schemes in Nyanza, Western, Central, and Coast Provinces |
| Other weavers that feed on small grain | Wheat | Milk | December - January and April - August | Rift Valley and Central Provinces |
| | Sorghum | Milk | January - March | Eastern Province |
| | Bulrush Millet | Any stage | January - March | Eastern and Central Provinces |
| | Finger Millet | Any stage | January - March and April - August | Eastern, Rift Valley, Nyanza, and Western Provinces |
| | Rice | Milk | Year-round | In respective schemes in Nyanza, Western, Central, and Coast Provinces |

N.B. The above given chart for crops with approximate time for damage and areas grown is more or less correct though sometimes will be affected by the rain start and the introduction of same crops to other provinces.

Table 3. Quelea damage in Kenya (DWRC 1974 Annual Report)

| CROP | TIME | DAMAGE AREAS | | WEATHER PATTERN | | | BREEDING SEASONS | OTHER |
|---|---|---|---|---|---|---|---|---|
| | | GENERAL | SPECIFIC | DRY | LONG RAINS | SHORT RAINS | | |
| WHEAT | Jul-Nov | West | Kitale<br>El Doret | May-Jun | Jul-Dec | Feb-Apr | Aug & Mar | Emergent Damage |
| | Jul-Aug | | Narok | | | | | Nyeri<br>Nanyuki |
| | Dec-Jan | Central | Nyeri<br>Nanyuki | May-Jun | Jul-Dec | Feb-Apr | Aug & Mar | Mar-Apr<br>Sep-Oct |
| | Jun-Oct | | Nakuru<br>Nyanadura | | | | | |
| RICE | Varies | West | Ahero<br>Bunyala | | | | | |
| | | Central | Mwea Tibere | | | | | |
| | May-Aug | East | Garissa<br>Ngau | Sep-Oct<br>Feb-Mar | Late Mar<br>- Aug | Late Oct<br>- Feb | Dec & Apr | |
| | Varies | North | Mandera<br>Turkwell | Sep-Oct<br>Feb-Mar | Late Mar<br>- Aug | Late Oct<br>- Feb | Dec & Apr | |
| MILLET<br>SORGHUM | Jan-Feb | Central | Machakos<br>Kitui | | | | | Emergent Damage<br>Machakos-Kitui<br>Oct-Nov |

Table 4. Quelea damage in Tanzania (DWRC 1974 Annual Report)

| CROP | TIME | DAMAGE AREAS | | WEATHER PATTERN | | | OTHER |
|---|---|---|---|---|---|---|---|
| | | GENERAL | SPECIFIC | DRY | LONG RAINS | SHORT RAINS | |
| WHEAT | Jul-Sep | Northeast | Sungate<br>Makuyuni | Jul-Nov<br>Feb | Mar-Jun | Dec-Jan | Emergent Damage<br>Sungate<br>Makuyuni<br>Mar-Apr |
| RICE | Jun-Sep | Northeast | Same | | | | |
| | May-Jun | Northwest | Musoma<br>Mwanza<br>Shinyanga | May<br>Oct | Nov<br>Apr | | |
| | Apr-Jun | Central | Rufigi Basin | Apr-Dec | Jan-Mar | | |
| | Mar-Jun | | Kilangali<br>Kilosa<br>Myomero | | | | |
| | Mar-Jun | South | Mbeya<br>Mbarali | May<br>Jan | Feb<br>Apr | | Emergent Damage<br>Mbarali<br>Oct-Nov |

Table 4 (continued

| CROP | TIME | DAMAGE AREAS | | WEATHER PATTERN | | | OTHER |
|---|---|---|---|---|---|---|---|
| | | GENERAL | SPECIFIC | DRY | LONG RAINS | SHORT RAINS | |
| MILLET SORGHUM | Jun-Jul | Northwest | Mwanza<br>Shinyanga | | | | |
| | Mar-May | Central | Singida<br>Dodoma<br>Morogoro | | | | |

TABL

STATUS OF VERTEBRATE PEST P

| Verte-brate Class | Vertebrate Order | Vertebrate Pest Species | |
|---|---|---|---|
| | | Common Name | Latin Name |
| Aves | Passeriformes | 1. Red billed weaver | Quelea quelea aethiopica |
| | | 2. House Sparrow | Passer domesticus arboreus<br>Passer domesticus niloticus |
| | | 3. Golden sparrow | Auripasser luteus |
| | | 4. Masked weaver | Ploceus taeniopterus |
| | | 5. Black-headed weaver | Ploceus cucullatus |
| | | 6. Yellow-backed " | Ploceus capitalis |
| | | 7. Cinnamon weaver | Ploceus badius |
| | | 8. Red bishop | Euplectes hordeacea |
| | | 9. Dura bird | Euplectes orix |
| | Columbiformes | 10. Dove | Streptopelia spp.<br>Stigmatopelia spp. |
| | Psittaciformes | 11. Rose-ringed parakeet | Psittacula krameri |
| Mamma- | Rodentia | 1. Multimammate rat<br>2. Nile (Grass) rat<br>3. - - | Mastomys natalensis macrolepi<br>Arvicanthis niloticus testicu<br>Acomys cabiricmus |

Modified and updated from 1975 tabulation by Sadig Beshir, previous Head of Bird and Rodent Control Section, Plant Protection Department, Khartoum North, Democratic Republic of the Sudan.

Wayne H. Bohl, 1/20/80

)BLEMS, 1979 IN THE SUDAN*

| | Crop Damaged | Method of Control |
|---|---|---|
| | All cereal crops | Aerial and ground spraying at nest colonies and roosts using fenthion + diesel oil. |
| | Cereals, fruits and vegetables | Nest destruction and scaring. |
| | " " | " " " " |
| | Cereals and fruits | Aerial spraying at roosts and colonies using |
| | " " | fenthion mixed with diesel oil, also, nest |
| | " " | destruction and scaring methods. |
| | " " | |
| | Cereals, fruits and vegetables | Scaring, nest destruction and trapping. |
| | Cereal crops | " " " " " |
| | Cereals, particularly ripening sorghum | Scaring and aerial spraying at roosts using fenthion mixed with diesel oil. |
| | Ripening fruits, i.e., guava | Scaring and shooting. |
| ris | Cereal crops, groundnuts, vegetables, fruits and | Zinc phosphide and warfarin poison baits. |

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