PART TWO P.95-203

REPORT ON THE FIRST NATIONAL SURVEY OF COMMUNAL AREAS OF ZIMBABWE, BY CROP PROTECTIONISTS FROM THE PLANT PROTECTION RESEARCH INSTITUTE IN THE DEPARTMENT OF RESEARCH AND SPECIALIST SERVICES, HARARE, DURING THE 1984/85 GROWING SEASON.

BY SAM L.J. PAGE Ph.D.*

CAMES M. MGUNI M.Sc. (PATHOLOGIST)

SIMON Z. SITHOLE M.Sc. (ENTOMOLOGIST)

*BASED AT THE TROPICAL PLANT NEMATOLOGY ADVISORY AND RESEARCH UNIT,

CAB INTERNATIONAL INSTITUTE OF PARASITOLOGY,

ST. ALBANS, AL4 OXU, ENGLAND

TABLE 9a

NEMATODE PESTS OF MAIZE

Nematode	Percentage incidence	Associated Symptoms
Pratylenchus spp. *P. zeae* *P. brachyurus*	60	chlorosis, stunting, reduced yield; root lesions
Rotylenchulus parvus	53	chlorosis, stunting, reduced yield
Paralongidorus ?n.sp.	12	chlorosis, stunting; failure to produce cobs; root-tip galls
Xiphinema spp. *X. louisi* *X.* cf. *variabile*	13	chlorosis, severe stunting; failure to produce cobs; root-tip galls
Scutellonema spp. *S. brachyurum* *S. magniphasmum* *S. unum*	50	chlorosis, stunting
Hoplolaimus pararobustus	4	chlorosis, stunting; root swellings and distortions
Meloidogyne javanica	6	chlorosis, stunting, root swellings
Telotylenchus obtusus		stunting
Paratrophurus sp.		stunting
Rotylenchus incultus		

Diseases of Maize and their control

Corn, *Zea mays*, is subject to a number of diseases that reduce both yield and quality. An estimate of yearly losses range from about 2 to 7% but in some localities one or more diseases may become acute and destroy a considerably higher proportion of the crop. Ear and kernel rots decrease yield, quality and food value of the grain. Stalk diseases may not only lower yield and quality but also make harvesting difficult. When leaves are damaged by disease the production of carbohydrates to be stored in the grain is lessened, and immature, chaffy ears result. Most of the parasitic or infectious diseases of corn are caused by fungi and a few by viruses.

Maize streak virus

Symptoms: Produces broken, narrow, yellow streaks along veins of leaves, the extent of which varies according to the age of the plant when infected. If this takes place soon after germination the whole plant will show the symptoms but from then on, only the leaves produced after infection has taken place will show the characteristic streaking. Also the earlier that infection takes place, the more reduced is plant growth. Any plants showing symptoms before flowering are unable to produce a satisfactory cob. In general irrigated crops show a higher percentage of infection than main season crops. During the survey maize plots were seen with virtually 100% infection, e.g. at Tamandayi communal land, where heavy losses were expected.

Control: Resistant varieties should be used and weed growth within the crop should be kept to a minimum. Also the efficient use of herbicides will help, since it is the weeds which serve as disease reservoirs, hence total elimination of weeds will help prevent the vector from spreading the disease within the crop. Use of insecticide to kill the vector. Main crop plantings should not be in the vicinity of earlier planted, irrigated crops.

Rust Disease

Cause: *Puccinia sorghi*

Symptoms: Produces circular to elongate, cinnamon brown, powdery pustules which arise on both surfaces of the leaf. Its life-cycle is typical of those rusts which have an alternate host.

The effect of this disease on maize varieties in Zimbabwe was estimated as being a 10% crop loss. It is thus a threat to the majority of communal farmers who are dependant on maize for their food.

Control: Use of resistant varieties.

Late Blight Disease

Cause: *Helminthosporium turcicum*

Symptoms: The lesions caused by this fungus first look as though water soaked, before they change to light brown and finally, as they dry out, dark brown to black. The disease starts on the lower leaves and then spreads to those above. The conidia, which are wind borne are produced abundantly on both surfaces of the leaves. The fungus overwinters in the maize trash.

The losses due to leaf blight vary from negligible amounts to as high as 50%.

Control: Use resistant varieties. The use of fungicides is justified in special circumstances.

Diplodia maydis

Symptoms: Rotting usually starts at the base and progresses towards the tip. In severe cases the entire ear may be rotten, such cobs having a grey-brown, shrunken, mummified appearance and being light in weight. On breaking the less infected cobs open, white fungal mycelium can be seen between the basal grains.

Yield loss due to this disease is estimated at between 2 to 20% depending on the severity of infection.

Control: Use of sound seed, combined with seed-dressing, is the best way of obtaining a full stand of maize. Use Captan and thiram.

TABLE 9b.

DISEASES OF MAIZE

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Maize streak virus	short, pale greenish-yellow streaks & spots over leaf surface	80-100	70-80	60-70	40
Helminthosporium turcicum	elliptical lesions; "water soaked", becoming brown-black, then tan coloured on lower leaves/whole plant				
Puccinia sorghi	small rusty raised spots/pustules on leaves	15	40	40	40
Diplodia sp.	cob rot	-	-	-	10
Cercospora fusimaculans	small leaf spots, enlarging to rectangular lesions	24	10	7	5

Insect Pests of Maize and their control

Maize which is grown mostly in the Farming Regions I, II and III is an important source of carbohydrate for the Zimbabawean masses. It is attacked by a variety of insects from the time it is planted to the time it becomes available to the consumer. Table 9c. shows insect pests that were encountered damaging maize at various stages of development in the field.

Stem-borers

Busseola fusca (maize stalk-borer), *Sesamia calamistis* (pink stem-borer) and *Chilo partellus* (spotted stem-borer) are the stem-borers which were encountered attacking maize in the field during the survey. It is the larvae of these insects which damage leaves (causing windows and shot-holes), create tunnels in the maize stems and destroy grain on cobs. Symptoms of stem-borer attack are destroyed growing points of plants ("dead hearts"), stunted growth, tillering and wilting of plants. Economically, stem borers are the most important of all insect pests of maize and they are capable of rendering the whole crop useless in cases of heavy infestation. It is not surprising, therefore, that the stem-borer is the most well known insect pest of maize in the communal areas. Stem-borer infestion was within the range from 30 to 50% though a few incidences of up to 70% were observed, for example in Zimunya West Communal Area. Clearly where the incidence is up to 70% the farmers can expect to get a yield no more than 40%.

Although some communal farmers carry out the normal crop husbandry practices with the advisory role of the Agritex personnel, little or no use of insecticides was observed. In the drive to control the menace of the stem-borer, communal farmers who can afford to purchase insecticides use thiodan 1% dust or dipterex 2.5G. It was also observed that where thiodan was in use dipterex was not used. The explanation from the Agritex personnel was that the communal farmers could only buy the insecticide that was available in their local shops even though it may be a less effective chemical, when compared with the others available elsewhere. The use of granular insecticides such as carbofuran 10G at planting time to control stem-borer is not practised by communal farmers. However, carbofuran 10G should not be recommended for use by communal farmers for safety reasons. There was only one farmer who indicated that he had used carbaryl in controlling stem-borers. We were pleased to note that DDT was no longer in use for stem-borer control. Cultural methods of control such as weed removal from the fields, early planting, burning of stalks and ploughing stubble under are practised but crop-rotation is not universally carried out by the farmers. It was the general observation that every communal farmer was keen to protect his maize crop but his poor financial status militated against his wishes.

Termites

Hodotermes and *Microtermes* spp. are termites of economic importance in communal agriculture as they damage many crops including maize. In the communal areas visited, prevalence ranged from 20% in Region I to 40% in Regions IV and V. Termites can cause high maize crop losses by cutting down plants using their sharp mandibles prior to damaging cobs on the fallen stalks.

Interviews with farmers clearly indicate that nothing is being done to contain termite damage on maize. Well over 90% of the farmers questioned were not aware of aldrin and dieldrin as registered insecticides for the control of termites on maize. However, owing to high persistence in the environment, these two insecticides are likely to be deregistered in the future.

Leaf hopper (Maize Streak Virus Vector)

Cicadulina mbila (leaf hopper) is an important vector of the maize streak virus disease which, when percentage infection is high, reduces yield drastically. Infestation in Region I (Tamandayi Communal Area) was estimated at 80% though in some fields it was up to 100% and 60 to 70% in one field in Zimunya West Communal Area in Region III. In Tamandai the incidence was so high that yields as low as 30% are expected in the 1984/85 growing season despite good rainfall received after three years of drought.

C. mbila can be controlled by applying carbofuran and dimethoate. These two chemicals need great care at the time of application and therefore are not recommended for use by communal farmers. Culturally, the insect vector could be controlled by eliminating weeds and volunteer maize plants, practising crop rotation and planting early before high *C. mbila* populations build up.

Armoured Crickets

Serious outbreaks of armoured crickets particularly *Acanthoplus* and *Enyaliopsis* spp. were observed attacking maize in Regions IV and V, where infestation rate was estimated at between 60 and 90%. In Hwange Communal Area the incidence was 100% (> 1 per plant) and consequently farmers were expecting low yields (Plate 2e). This pest is capable of destroying the whole maize crop if the infestation is heavy. Fortunately, these crickets are not a regular pest but periodic in occurrence.

No insecticides have been registered for the control of armoured crickets in Zimbabwe but Carbaryl 85 w.p. has been used in Hwange Communal Area where it was observed to be completely ineffective. However, it is highly likely that the farmers may not have used the right quantity to combat such a high infestation. Clearly the control of armoured crickets demands urgent attention by plant protection research in the communal areas.

White grubs

White grubs such as *Eulepida mashona* are pests of economic importance in maize crop husbandry. They dwell in soil and attack the root system of maize plants. Seed germination occurs and a satisfactory stand is established but within a short period when plants are 100 to 150 mm tall, seedlings begin to die.

Stand loss can occur within 7 to 10 days in severely infested fields. One grub is capable of destroying all plants along a 5 m row. Infected plants that are not killed at the seedling stage become severly stunted and never produce grain. Infected plants that do not die, often have insufficient roots to prevent them from lodging. Lodging plants were observed in some communal farms where incidence was about 30%. Generally it is not easy to recognize white grubs unless the soil is dug up. They are often exposed during ploughing when chickens follow plough furrows, and pick them up. White grubs are closely associated with such host trees as Brachystegia speciformis (Msasa tree) and Julbernardia globiflora on which the adults roost and feed.

In the absence of chemical control the following control measures are recommended for use by the communal farmer: early or delayed planting depending on white grub species, and rotation with a non-graminaceous crop.

Maize Aphid

The maize aphid, Rhopalosiphum maidis, is a small, soft-bodied, green insect occurring in large colonies on leaves and inflorescences, where it causes sterility. The incidence of aphids ranged from about 20% in Regions IV and V, to between 30 and 40% in Regions I to III. The impact of this pest on maize yield is very slight.

Demeton-s-methyl, dimethoate and thiometon are registered chemicals for the control of aphids on maize but are not to be recommended for use by the communal farmers since they are very toxic. However, control of aphids by applying insecticides is seldom justified because even when they are present in relatively large numbers, yield losses are rarely severe. Although the pest is readily controlled by organophosphates, especially systemic insecticides, their cost is beyond the economic viability of the communal farmers.

Elegant Grasshopper

Zonocerus elegans (elegant grasshopper) is a polyphagous insect capable of damaging young maize severly. It was observed in comparatively large numbers in Regions IV and V, where incidence was estimated to be 30% while that of Regions I to III was about 20%. *Z. elegans* is a periodic pest of maize in the communal areas where it can cause heavy yield losses in times of severe outbreaks.

Since incidences of the elegant grasshopper on maize are generally low, no control is carried out. Carbaryl 85 w.p. and diazinon 30 e.c. are effective for the control of this pest whenever it occurs in numbers large enough to warrant chemical application.

Snout Beetles

Snout beetles, comprising three main species, *Systates exaptus*, *Mesoleurus dentipes* and *Tanymecus destructor*, are troublesome maize pests in the commercial sector of the Zimbabwean agricultural system but there was no indication that they have attained the same pest status in the communal sector.

However, 30% was the highest infestation rate estimated on the limited amount of land set aside for communal areas in Region I while it was 10% in Region V and 20% in Regions II to IV.

Although no control measures are taken against the adult snout beetles in the communal areas, outbreaks that warrant insecticidal spraying can be controlled by using carbaryl 85 w.p. Good weed control together with delay by three weeks in planting give effective control. A delay in planting by three weeks permits the grubs to undergo pupation, the developmental stage which does not damage seedlings.

American Bollworm

The american bollworm, *Heliothis armigera*, damages grain on the cob at the soft dough stage but incidence is very low in the communal areas as shown in Table 9c. Carbaryl 85 w.p. is an effective insecticide for the control of this pest whenever infestation warrants control.

Blister Beetles

Blister beetles, e.g. *Mylabris* spp., were observed hovering around cob silk and tassels but infestations were very low and their impact on yield negligible. However, whenever the need for control arises, carbaryl 85 w.p. should be effective.

Cutworms

Cutworms, *Agrotis* spp., cut off maize plants at or slightly below the soil surface. the larvae are nocturnal in habit, coming above ground from their hiding places in the soil to feed on the surrounding plants. Infestation rates were 10% in Region V, 30% in Regions I and III and 20% in Region II.

Cutworm control is not practised in communal areas because their impact on yield is thought to be insignificant. For the communal farmers, the following control measures are highly recommended:

1. Ploughing under of vegetation in late summer or three to six weeks prior to planting.
2. Destruction of weed hosts.
3. Thorough land preparation.
4. Practising crop rotation.

TABLE 9c . Insect Pests of Maize. The incidence and severity of damage estimates are designated by a score between zero and ten. (0, no incidence; 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 7 - 8, high incidence; 9 - 10, very high incidence). Roman numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Maize stalk borer	*Busseola fusca*	4	5	4	3	3	2
Spotted stem borer	*Chilo partellus*	4	5	4	3	3	2
Pink stem borer	*Sesamia calamistis*	4	5	4	3	3	2
Termites	*Macrotermes* spp. *Hodotermes mossambicus*	2	3	3	4	4	3
Leaf hopper (streak vector)	*Cicadulina mbila*	8	4	2	0	0	4
American bollworm	*Heliothis armigera*	0	1	1	0	0	11
Elegant grasshopper	*Zonocerus elegans*	2	2	2	3	3	6
White grubs	e.g. *Eulepida mashona*	2	3	2	1	1	10
Maize aphid	*Rhopalosiphum maidis*	3	3	4	2	2	5
Blister beetles	*Mylabris* sp.	1	1	1	1	1	9
Cutworms	*Agrotis* spp.	3	2	3	2	1	8
Snout beetles	e.g. *Systates* spp.	3	3	2	2	1	7
Armoured crickets	*Acanthoplus* spp. *Enyaliopsis* spp.	3	4	4	6	9	1

2. SORGHUM

Sorghum, Sorghum vulgare, is important both as a food crop and a cash crop in communal areas. Its drought resistant properties make sorghum a more reliable crop than maize in Farming Regions IV and V. 'Red Swazi A' is the most popular cultivar for the production of sorghum destined for the brewing industry, but the traditional white varieties are preferred for home consumption, despite being plagued by flocks of Quelea birds. Sorghum is normally grown in rotation with other cereal crops, especially maize and as a result, was suffering from many of the same pest and disease problems.

Nematode Pests of Sorghum and their control

Root-Lesion Nematode, Pratylenchus spp.

Pratylenchus spp., P. zeae or P. brachyurus, was present in 64% of the sorghum fields that were sampled with populations in excess of 2,000 per litre of soil in Mutema communal area (Plate 2). Symptoms of infection were the same as those already described for maize, i.e. chlorosis and stunting, which was often severe, especially when the sorghum was following a crop of maize. Control of Pratylenchus should be by crop rotation and the use of resistant cultivars (see Section E).

Reniform Nematode, Rotylenchulus parvus

Thirty-two percent of the sorghum fields included in the survey were infested with Rotylenchulus parvus, the highest numbers of immature females and juveniles being found in soils in Ntabazinduna communal area. Associated symptoms were stunting and chlorosis though information regarding actual yield losses is not yet available. It may be possible to control this nematode by crop-rotation.

Needle Nematode, Paralongidorus sp.

Paralongidorus sp. was found in only a few sorghum fields but it was associated with the same severe growth reductions as were observed with maize. The pathogenicity of this nematode must be established before suitable control measures can be implemented.

Dagger Nematode, Xiphinema spp.

This nematode was also associated with stunted growth in sorghum resulting from poor root development and root-tip galling. Xiphinema sp. invariably occurred with Pratylenchus spp. and the possibility of a syngergistic effect deserves investigation.

Other Nematodes associated with Sorghum

Hoplolaimus pararobustus, Histotylenchus histoides, Helicotylenchus sp., Scutellonema unum, S.brachyurum, S. cf. truncatum, Telotylenchus obtusus, Paratrophurus sp. and Rotylenchus incultus were all associated with stunted and chlorotic sorghum, although they rarely occurred in isolation being more likely to be sharing the same habitat as Pratylenchus spp. or Rotylenchulus parvus. These nematodes are not thought to be limiting factors in sorghum production at present.

TABLE 10a

NEMATODE PESTS OF SORGHUM

Nematode	Percentage incidence	Associated symptoms
Pratylenchus spp. P. zeae P. brachyurus	64	chlorosis, stunting; reduced yield; root lesions.
Rotylenchulus parvus	32	chlorosis, stunting; reduced yield.
Paralongidorus sp.		chlorosis, stunting; delayed flowering; reduced yield; root-tip galls.
Xiphinema spp.		chlorosis, stunting; reduced yield; root-tip galls.
Scutellonema spp. S. unum S. cf. truncatum S. brachyurum	50	chlorosis, stunting.
Hoplolaimus pararobustus		chlorosis, stunting; root swellings and distortions.
Helicotylenchus sp.		stunting.
Telotylenchus obtusus		stunting.
Histotylenchus histoides		stunting.
Paratrophurus sp.		stunting.
Rotylenchus incultus		stunting.

Diseases of Sorghum and their control

Diseases have become a factor limiting sorghum production in the better rainfall areas. The main diseases are leaf blight, downy mildew, rust, anthracnose and various smut diseases which attack the infloresence. All these diseases cause lesions or smut on leaves and heads with a consequent loss in yield. Other less common diseases of sorghum include covered smut, head smut, and head moulds. Covered smut is seed-borne and should not occur if the seed is properly treated.

Rust Disease

Cause: *Puccinia purpurea*

Symptoms: The first symptoms are small flecks on the lower leaves (purple, tan or red depending on the cultivar). Rust pustules (uredosori) develop mainly on the lower leaf surfaces which rupture to release reddish powdery masses of uredospores. The pustules are elliptical and lie between and parallel with leaf veins. The pustules may also occur on leaf sheaths and on inflorescence.

Control: The most effective and the only practical means to control rust is through the use of sorghum varieties resistant to infection by the pathogen. Several fungicides such as Zineb and sulphur compounds can effectively control rust.

Downy Mildew Disease

Cause: *Sclerospora sorghi*

Symptoms: The first few leaves show symptoms on the lower portion with a lighter green or yellow colouration of the infected portion. Abundant downy white growth (conidiophores and condia) is produced nocturnally on the under surfaces of infected portions of leaves during humid weather. Subsequent leaves on systemically infected plants show progressively more symptoms until the entire leaf blades are discoloured and support condial production. Three to four leaves develop the chlorotic downy growth type of symptoms. Subsequent leaves show progressively more of a complete bleaching of the leaf tissue sometimes in streaks or stripes.

Control: Use Captan.

Anthracnose Disease

Cause: *Colletotrichum graminicola*

Symptoms: There are two types of symptoms caused by this pathogen: a) Anthracnose, b) red stalk rot.

The anthracnose phase is characterised by small eliptical to circular spots up to 5 mm in diameter but often smaller, which develop small circular straw coloured centres and wide purple, red or tan margins (depending on the host cultivar). Few or numerous black spots are seen on the surface of the centres of the lesions which are the fruiting bodies (acervuli) of the causal fungus.

The red-rot stage may occur in stalks and/or in the inflorescence and is characterised externally by the development of circular cankers particularly in the inflorescence. Infected stems when split open show discolouration (depending on cultivar) which may be continuous over a large area, or more generally discontinuous giving the stem a marbled appearance.

Control: Variatal resistance to both the leaf and stem phase of the disease are required.

Leaf Spot Disease

Cause: *Cercospora sorghi*

Symptoms: This begins as small leaf spots which enlarge to become rectangular lesions that can be 5 to 15 mm long by 2 to 5 mm wide. The lesions are typically dark red to purplish with somewhat lighter centres. The lesions occur on leaf blades and sheaths and are mostly isolated but can form continuously to give long stripes.

A greyish white bloom is produced on the lesions when the fungus produces conidiophores and conidia.

Control: Control with mancozeb. Use resistant lines.

Head Smut Disease

Cause: *Sphacelotheca reiliana*

Symptoms: The head is either completely or partially replaced by a large whitish gall. The galls are at first covered by a whitish grey membrane of fungal tissue which ruptures, often before the head emerges from the boot, to expose a mass of brown-black powder (smut spores) among which are embedded long thin dark-coloured filaments. These are the vascular bundles of the infected head.

Control: The smut is best controlled by seed dressings, which should be applied as a routine precaution.

Covered Smut Disease

Cause: *Sphacelotheca sorghi*

Symptoms: The individual grains are replaced by smut sori which can be localized at a particular part of the head, or can occur over the entire inflorescence. The individual sori are oval or conical and are covered with a tough white or cream to light brown skin (peridium) which often persists unbroken up to thrashing.

Control: Chemical - quintozene; Thiram - both as seed dresses. The best control is by seed dressings, which should be applied as a routine precaution.

Loose Kernel Smut Disease

Cause: *Sphacelotheca cruenta*

Symptoms: The host plants invariably flower prematurely and often show increased tillering. The inflorescences are characteristically looser and bushier with hypertrophy of glumes and often spikelet proliferation. Normally all florets of infected heads are smutted and sori can also occur on the rachis and branches of the inflorescence. A characteristic feature of the sori which vary in length from 3 to 18 mm is the solid long black (often curved) pointed columella which extends almost the full length of the sorus and which remains conspicuous after the smut spores have been blown away.

Control: Chemical - quintozene (Brassicol); Thiram - both as seed dresses. Control by seed dressing, which should be applied as a routine precaution.

Root-Rot or Charcoal Rot Disease

Cause: Macrophomina phaseolina

Symptoms: External symptoms are lodging and poor grain filling. The sclerotial stage of the causal fungus, Sclerotium bataticola, invades the crown via the roots and then proceeds to colonize and disorganize the cortical tissues of the lower internodes. The lower stems of infected plants become soft and weak resulting in lodging usually at the second or third internode. Internal symptoms: if an infected plant is split open the vascular fibres are seen to be clearly separated and are usually heavily coated with the small, hard, black sclerotia of the causal fungus which gives the disease the name charcoal rot. Infection is related to drought stress and high soil temperatures during the grain filling period.

Control: Chemical - quintozene (Brassicol); Thiram.

TABLE 10b

DISEASES OF SORGHUM

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Sphacelotheca sorghi	individual grains replaced by small conical, cream to light brown sacs containing black powder	-	50	13	-
Sphacelotheca cruenta	grains converted into sacs of black powder, embedded with conspicuous long, black, curved structures	-	-	11	-
Sphacelotheca reilina	panicle converted into large, whitish sac full of black powder and long dark filaments	-	-	15	16
Helminthosporium turcicum	lesions with dark margins, & indistinct yellow halos, bearing a faint, grey to brown bloom	10	12	15	15
Puccinia purpurea	red to brown discrete powdery masses under leaf surface, forming pustules later	-	30	30	10
Macrophomina phaseolina	lodging; poor grain filling; stems internally disintegrated and sprinkled with small black bodies	-	-	5	10
Colletotrichum graminicola	small circular to oval lesions speckled with black dots on leaves; red-rot in stalks or inflorescence with external circular cankers	-	-	-	40

TABLE 10b (cont.)

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Sclerospora sorghi	dull grey to white downy mildew	-	-	-	13
Phyllastica sorghiphila	leaf spots	-	-	-	15
Curvularia sp.	head mould	-	-	-	4
Cercospora sorghi	dark red to purplish lesions, producing a greyish white bloom, on leaf blades & sheaths	-	10	-	11
Fusarium heterosporum	dry rot and red/brown internal discolouration of the rachis	-	30	-	13

Insect Pests of Sorghum and their control

Until recently protection of sorghum against insect pests received little critical attention. Insect pests observed attacking sorghum at various developmental stages are shown in Table 10c. together with their approximate incidences and ranks of economic importance.

Stem-Borers

These comprise the maize stalk borer, Busseola fusca, spotted stem borer, Chilo partellus, and pink stem borer, Sesamia calamistis. Stem borers are economically the most important insect pests of sorghum in the commercial and communal sectors. In the communal areas, the stem borer incidence ranges from 30 to 50%. The larvae of these stem borers cause the formation of small elongated and transparent windows on leaves as the first indication of plant infestation. With attack increasing in severity, plants become ragged and subsequently the larvae bore their way into stems, causing the appearance of shot-holes in whorl-leaves. Dead heart symptoms appear in young plants and stems are extensively tunnelled internally. Heavy stemborer infestations are capable of suppressing sorghum yields to an extent that a farmer gets less than 50% of the expected yield in cases where no control measures are taken.

Few communal farmers that grow sorghum take trouble to control stem-borers. Some of the measures that a farmer could take to reduce the density and menace of stem borers on sorghum include the destruction of dry stalks and stubble by burning or ploughing under, early planting, growing stem-borer-resistant varieties and practising crop-rotation. It must be emphasised that at the present moment no sorghum varieties are known to be resistant to stem borers and unfortunately, only carbaryl is registered for the control of stem-borers on sorghum in Zimbabwe. However, the Research and Specialist Services, Department of the Ministry of Agriculture is surrently carrying out field trials in an attempt to find insecticides whose efficiencies and cost are suitable for the control of stem-borer infestations on sorghum in the communal areas.

Aphid Infestation

The sorghum aphid, Aphis sorghi or Melanaphis sacchari and the maize aphid, Rhopalosiphum maidis, are the most important aphid species attacking sorghum in the communal areas. They are a second priority insect pest of sorghum. Heavy infestations are capable of suppressing yields severely by sucking plant juices and thereby causing yellowish mottling of leaves, some marginal leaf necrosis, plant size reduction and poor growth. Large quantities of honey-dew are produced by aphids and this encourages the development of mould. Honey-dew encumbered panicles hinder harvesting. Aphid infestation on sorghum was estimated to range from 20 to 40%. A. sorghi was more prevalent than R. maidis. Aphids are much more serious as pests of sorghum in drought years (such as there has been for the past three seasons) than in years of good rainfall.

The communal farmers are doing virtually nothing to control these aphid infestations and the majority of them see no need to take such control measures. A number of insecticides are registered in Zimbabwe for the control of aphid infestations on sorghum. In order of their increasing efficiencies, these are dimeton-s-methyl 20 e.c., dimethoate 20 w.p. and 40 e.c., endosulfan 47 w.p., malathion 5d and 50 e.c., parathion 50 e.c. Only dimethoate 20 w.p. and malathion 5d and 50 e.c. may be recommended for use by the communal farmer. The others are very dangerous and should be handled only by trained personnel. Crop rotation, weed removal, planting of aphid-resistant varieties and early planting are very successful control measures which can be recommended to communal farmers.

Shoot-Fly

The larval stage of the shoot-fly, Atherigona sp., feeds on the central leaf of young sorghum plants causing them to wilt and ultimately dry up, giving the characteristic "dead heart" symptom. The dead heart can be easily pulled out and the base emits a bad smell. Although the amount of infestation ranges from 20 to 30%, the shoot fly is snot an insect pest of real economic importance in relation to other insect pests of sorghum. However, this does not mean that heavy infestations are not experienced, as one farmer in Mutema communal area was likely to lose up to 50% of his expected crop yield due to shoot fly damage, probably because he planted his crop very late.

There is no chemical registered for the control of the shootfly on sorghum in Zimbabwe but carbofuran granules (10G) applied at planting time are known to effectively control this pest in South Africa (Van Rensburg *et al*., 1978). However, the more promising control measures recommended to the communal farmer are adjustments of planting dates, high seeding rate, use of high-yielding and shoot-fly-resistant varieties. Observation at the Kadoma Research Station indicated that the incidence of the shootfly is less on an early planted sorghum than on a late one.

Green Stink Bug

The green stink bug, *Nezara viridula*, was observed in all the five Farming Regions and its incidence varied from 10 to 30%. Nymphs and adults of this bug attack sorghum leaves and panicles. They suck sap from developing grain and as a result the grain is shrivelled and sorghum yield drastically reduced. However, *Nezara* infestations are not very serious in the communal areas. It was noted during the survey that open-type heads were less susceptible to attack than the compact ones.

Although no chemical has been registered for the control of the green stink bug in Zimbabwe, carbaryl 85 w.p. is used in some countries and is known to be effective. Such practices as keeping the fields weed-free, crop rotation, planting early in the season and the growing of resistant varieties are highly recommended to the communal farmers who may not be able to afford costly insecticides whenever they become registered and released into the market.

Sorghum Midge

Damage to sorghum is caused by the larvae of the sorghum midge, *Contarinia sorghicola*, feeding on the ovary. This prevents normal grain development and culminates in a "blasted panicle" and a heavy yield loss. The midge which is more common in the communal areas of low altitude characterised by high temperatures and humidity had an estimated incidence as between 20 and 30%. Interviews with the farmers revealed that at times serious outbreaks with resultant heavy losses in yield do occur.

Communal farmers do not protect their sorghum from damage by the midge and it is unfortunate that no insecticide has yet been registered which will control this pest in Zimbabwe. In some countries disulfoton is recommended for midge control. In the absence of a registered insecticide suitable for use by the communal farmer, loss of yield due to midge damage could be minimised by early planting and planting midge-resistant varieties.

American Bollworm

The larvae of the american bollworm, *Heliothis armigera*, were observed infesting sorghum heads and feeding on developing grain. They are also capable of damaging tender whorl-leaves by their feeding action. This pest is of economic importance because heavy infestations, whenever they occur, are capable of destroying the whole crop. High incidences were not observed but 30% infestation was the estimate in Regions IV and V and less than this percentage elsewhere.

Carbaryl and endosulfan are registered for the control of the american bollworm on sorghum in Zimbabwe but only carbaryl is considered safe for use by the communal farmer. Crop-rotation is extremely useful for the control of the bollworm. Open-type sorghum panicles are less affected as the larvae which feed on them are exposed to predacious insects and birds which play an important role in reducing bollworm populations.

Armoured Crickets

Acanthoplus amastiventris, A. speiseri and Enyaliopsis petersi were the armoured crickets observed attacking sorghum in communal areas. Incidences were particularly high in Hwange, Beit Bridge, Chiredzi, Ndowoyo, Chisumbanje and Mzarabani communal areas. These are essentially very dry areas in Farming Region V where rainfall is very patchy and below 350 mm. The incidence of armoured crickets is more or less confined to communal areas in Regions IV and V. Although they are regarded as an irregular insect pest, they may destroy the whole sorghum crop when outbreaks are severe. The infestation rate ranged between 90 and 100% in Hwange communal Area. The crickets could be seen climbing up sorghum plants to feed on the grain. Communal farmers in the areas where cricket outbreaks occurred this season, are likely to have had their yields reduced by between 40 to 80%.

In the absence of a registered insecticide for the control of the armoured crickets the communal farmers have been using carbaryl 85 w.p. but this has been reported to be only partically effective. In Hwange, carbaryl was reported to be completely ineffective. However, the knock-down power of carbaryl on large orthopterous insects is slow when compared with that of fenitrothion 30 e.c. which has the much needed quick knock-down result. It is highly probable that the communal farmers who applied carbaryl 85 w.p. in Hwange communal Area did not apply it in the correct quantity needed for an effective result.

Grasshoppers

Zonocerus elegans (elegant grasshopper), *Cataloiipus cognatus*, *Pycnodictya kilosana*, *Oedaleus* sp., *Lobosceliana loboscelis* and *Gastrimargas crassipes* were observed on sorghum and their incidence as a group was estimated to be approximately 20%. Communal farmers who were visited indicated that these grasshoppers are not a threat to their sorghum yields.

Birds

Interviews with communal farmers growing sorghum and millet indicated that birds such as *Quelea quelea* (Ploceidae) and doves (Columbiformes) cause huge losses of grain. The *Quelea* birds are particularly damaging when the grain is at the soft dough stage while doves feed on grain at the hard dough stage. Flocks of *Quelea* birds are capable of eating the whole crop if they are not controlled. In Regions III, IV and V, the incidence of birds ranged from 30 to 40%. Clearly these have a considerable impact on the sorghum yields. Although incidence was found to be highest in Regions III, IV and V, it was not easy to distinguish grain damage due to birds from that due to grasshoppers and caterpillars at first sight there is much similarity between ears with aborted seeds and those with seeds eaten by birds. However, grain eaten by birds leaves an albumen deposit outside the glumes, caused by the pinching action of the beak. The deposit is visible as a white juice or powder on the damaged ear. During the survey it was observed that the red sorghum varieties were less susceptible to bird attack than white varieties. This difference in susceptibility may be ascribed to the difference in taste, the red varieties being bitter while the white varieties are more palatable to birds. Scaring methods such as beating empty tins, shouting and whistling are used to frighten away the birds though they are boring and time consuming.

TABLE 10c. Insect Pests of Sorghum. The incidence and severity of damage estimated are designated by a score between zero and ten (0, no incidence; 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 7 - 8, high incidence; 9 - 10, very high incidence). Roman Numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Maize stalk borer	*Busseola fusca*	4	3	3	4	5	1
Spotted stem borer	*Chilo partellus*	4	3	3	4	5	1
Pink stem borer	*Sesamia calamistis*	4	3	3	4	5	1
Termites	*Macrotermes* spp. *Hodotermes mossambicus*	0	2	1	1	2	14
American bollworm	*Heliothis armigera*	0	0	0	3	3	13
Elegant grasshopper	*Zonocerus elegans*	0	0	1	4	4	10
Armoured crickets	*Acanthoplus* spp. *Enyaliopsis* spp.	0 0	0	1	5	9	4
Maize aphid	*Rhopalosiphum maidis*	2	3	3	4	4	3
Sorghum aphid	*Aphis sorghi*	3	3	3	4	4	2
Shoot fly	*Atherigona soccata*	0	2	2	2	3	9
Green stink bug	*Nezara viridula*	1	1	1	3	3	8
Cotton stainers	*Dysdercus* spp.	0	1	1	3	3	11
Sorghum midge	*Contarinia sorghicola*	0	3	2	2	3	7
Coreid bugs	*Anoplocnemis curvipes*	0	4	1	3	3	6
Grasshoppers	*Cataloipus cognatus* *Pycnodictya kilosana* *Oedoleus* sp. *Loboscelian loboscelis* *Gastrimargas crassipes*	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	2 1 1 1 1	3 2 2 2 2	9 18 17 16 15
Birds	*Quelea quelea*	0	2	3	4	4	5

3. FINGER MILLET

Finger millet, Eleusine coracana, is grown in all communal areas throughout Zimbabawe as it is the vital ingredient for traditional, ceremonial beer. It is also an important famine food as it can be stored for more than ten years without deterioration or weevil damage. Short varieties are the most popular. These take only a little over three months to mature, and can be used to fill in areas where the maize has failed when the rains are late.

Nematode Pests of Finger Millet and their control

The nematodes listed in Table 11a were all extracted from samples of finger millet roots and soil. Those causing the most serious damage were Rotylenchulus parvus and Meloidogyne javanica. In the case of R. parvus the symptoms were not clearly defined, consisting of general chlorosis and reduction in growth. The root-knot nematode, M. javanica, feeds endoparasitically and is responsible for galling of the root tissue which, in addition to chlorosis and severe stunting, is characteristic of this pest. There appeared to be significant yield losses resulting from infections by these nematodes. Finger millet plants that were heavily infested with root-knot nematodes were usually being intercropped with a susceptible broad-leafed crop such as melon, okra or cowpea and it is highly likely that these intercrops provided the source of infection. The level of damage being caused by other nematodes included in Table 11a could not be determined accurately by field observations and consequently require further investigation. However, the fact that finger millet is susceptible to the most damaging nematode pests of maize, is sufficient information alone to suggest that farmers should not rotate this crop with maize unless other non-graminaceous crops are interspersed.

TABLE 11a

NEMATODE PESTS OF FINGER MILLET

Nematode	Associated Symptoms
Pratylenchus spp.	chlorosis, stunting; reduced yield.
P. zeae	
P. brachyurus	
Rotylenchulus parvus	chlorosis, stunting; reduced yield.
Paralongidorus sp.	chlorosis, stunting; reduced yield; root-tip galls.
Xiphinema louisi	chlorosis, stunting; reduced yield; root-tip galls.
Scutellonema spp.	chlorosis, stunting.
S. unum	
S. brachyurum	
Criconemella sphaerocephala	stunted growth.
Histotylenchus histoides	stunted growth.
Meloidogyne javanica	chlorosis, severe stunting; poor yield; root swellings.

Insect Pests of Finger Millet and their control

Stem borers, *Sesamia calamistis* and *Chilo partellus*; green stink bug, *Nezara viridula*; leaf hopper, *Cicadulina mbila*; elegant grasshopper, *Zonocerus elegans*; tip-wilter, *Caura rufiventris*; aphid, *Cheilomenes* spp.; termites, *Macrotermes* spp. and *Hodotermes mossambicus*; rapoko bug, *Rhynocoris segmentarius*; *Sagra stevensi*; shootfly, *Atherigona soccata*; snout beetles, *Systates examptus* and armoured crickets were observed attacking finger millet during the survey and their incidences are shown in Table 11c. Stem borers, aphids, termites, *C. mbila* and the finger millet bug were the insect pests that could be regarded as being of economic importance as their incidences in the communal areas ranged between 10 and 30%. Good crop husbandry practices should be satisfactory in controlling these pests.

TABLE 11c. Insect Pests of Finger Millet. The incidence and severity of damage estimated are designated by a score between zero and ten. (0, no incidence; 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 7 - 8, high incidence; 9 - 10, very high incidence). Roman numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Stem borers	*Sesamia calamistis* *Chilo partellus*	2	2	2	0	0	2
Green stink bugs	*Nezara viridula*	2	2	1	0	0	3
Leaf hopper	*Cicadulina mbila*	3	1	0	0	0	6
Elegant grasshopper	*Zonocerus elegans*	1	1	1	0	0	7
Tip wilters	*Caura rufiventris*	1	1	1	0	0	7
Ladybirds	*Cheilomenes* spp.	1	2	2	0	0	3
Termites	*Macrotermes* spp. *Hodotermes mossambicus*	1	2	2	0	0	3
Rapoko bug	*Rhynocoris segmentarius*	1	3	3	0	0	1
Chrysomelid beetles	*Sagra stevensi*	0	1	2	0	0	7
Shoot fly	*Atherigona soccata*	0	1	1	0	0	10
Snout beetles	*Systates examptus*	0	1	1	0	0	10
Armoured crickets	*Acanthoplus armativentris*	0	0	0	0	0	12

4. BULRUSH MILLET

Bulrush millet, *Pennisetum typhoides*, is grown mainly in communal areas in Farming Regions IV and V as it gives reliable yields in poor, sandy soil with low rainfall. It requires few inputs and is less susceptible to *Striga* spp., *Aphis* spp., stalkborers and some nematode pests than sorghum or maize but has the serious disadvantage of being attacked by *Quelea* birds. Considering the good storage properties and high nutritional content of the grains, particularly regarding proteins and B vitamins, (which can be exploited without the need for pounding) this crop receives comparatively little attention in breeding programmes.

Nematode Pests of Bulrush Millet and their control

The nematode pests that were collected from bulrush millet fields during the survey are listed in Table 12a.

Most of these nematode pests are common to the other important cereal crops which are grown in communal areas of Zimbabwe. The root-lesion nematode, *Pratylenchus* spp., was found causing the same chlorotic, stunted growth of bulrush millet as was commonly associated with infested maize plants (Plates 1a & 2b). *Paralongidorus* n.sp. and *Xiphinema* spp. were also responsible for the same severe stunting of both roots and shoots of bulrush millet.

It is obvious, therefore, that continuous cropping of the above mentioned cereal crops will inevitably lead to the build-up of damaging nematode populations and the long-term decline in yield of these crops, with the farmer becoming increasingly dependant on inorganic fertilizers in the hope of arresting the situation. Whenever large populations of nematode pests were uncovered during the survey, the resultant poor growth of the host plants was being blamed on "poor soil" by farmers and extension workers alike. Even with improved awareness these nematode problems cannot be solved until farmers have a wider variety of cultivars and crops available for rotation with their main cereal crops (see Section E).

TABLE 12a

NEMATODE PESTS OF BULRUSH MILLET

Nematode	Associated Symptoms
Pratylenchus spp.	chlorosis, stunting; reduced yield; root lesions.
Paralongidorus ?n.sp.	chlorosis, stunting; root-tip galls.
Xiphinema sp.	chlorosis, stunting; root-tip galls.
Scutellonema spp. *S. unum*	stunting.
Telotylenchus obtusus	stunting.
Histotylenchus histoides	stunting.
Helicotylenchus sp.	stunting.

Diseases of Bulrush Millet and their control

Smut Disease

Cause: *Tolyposporium penicillariae*

Symptoms: Florets are infected and transformed into large sacs (sori) containing black powder (smut pores). When young the sori are larger and greener than the non-infected developing seed and they remain green when the normal seeds become creamy or grey coloured. As the sori mature they become dark brown and are easily broken, spilling out millions of black smut spores.

Control: Cultural - Select cultivars which are tolerant varieties to the disease. Chemical - seed dressings: quintozine (Brassicol) 25 g per 100 kg seed; Thiram 180 g per 100 kg seed.

Rust Disease

Cause: *Puccinia penicillariae*

Symptoms: First appear on the lower older leaves as typical erupent pustules containing a reddish-brown powder (uredospores). As the leaves senesce, dark brown teliospores are produced sometimes in the uredosori, or in telentosori which are darker coloured than uredosori. Symptoms can occur on upper and lower surfaces of the leaves but are more common on the upper surface.

Control: Chemical - use mancozeb, thiram or zineb. For cultural control - select tolerant varieties.

TABLE 12b.

DISEASES OF BULRUSH MILLET

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Puccinia penicillariae	Reddish-brown powdery leaf pustules	-	15	34	30
Tolyposporium penicillariae	bright green/black	-	-	30	-
Cercospora sp.	leaf spots	-	-	15	9

Insect Pests of Bulrush Millet and their control

Bulrush millet plants are subject to attack by stem borers, *Busseola fusca*, *Sesamia calamistis* and *Chilo partellus*, maize aphid, *Rhopalosiphum maidis*, sorghum aphid, *Melanaphis sacchari*, termites, elegant grasshopper, *Zonocerus elegans*, green stink bug, *Nezara viridula*, blister beetles, *Mylabris* spp., american bollworm, *Heliothis armigera*, armoured crickets, *Acanthoplus* spp. and *Enyaliopsis* spp. and cotton stainer, *Dysdercus* spp. These insects which were observed on bulrush millet during the survey are shown in Table 12c. together with their estimated incidence and severity scores.

Stem-borers

The stem-borer complex in Zimbabwe consists mainly of *B. fusca*, *S. calamistis*, *Chilo partellus* and *Acigona ignefusalis*. Damage symptoms are generally evident about 4 to 6 weeks after germination. Stem-borer attack is indicated by the presence of insect frass and shot-holes on leaves and stems. Larval feeding on stems results in the death of the growing points ("dead hearts"). Death of the main plant gives rise to profuse tillering with unproductive heads. Late attack may result in "blasted" or "chaffy" heads without seed, breakage of peduncles or lodging (Gahukar, 1984). Stem-borer infestation of pearl millet was estimated to be 20% in the Regions II and III and 30% in IV and V.

Stem-borer attack on bulrush millet is not being controlled by communal farmers at present. Careful disposal of crop residues which will destroy diapausing larvae helps in reducing the population of these pests. To control the spread, late sowings should be discouraged although early planted short-cycle bulrush millets may experience the first generation borer attack. The use of insecticides is not practical or economical on tall traditional varieties which are popular with the communal farmers.

Aphids

The maize aphid, R.maidis, and sorghum aphid, M. saccharis, cause withering of leaves, whorls and heads. The maize aphid is also a vector of virus diseases. Aphid infestation on bulrush millet ranged from 20 to 30% in Regions III, IV and V. Yield losses due to aphid attack can be heavy when incidence is high.

Early planting and good crop husbandry practices are helpful in controlling the menace of aphid attack. The use of resistant varieties may be a solution to aphid infestion.

Green Stink Bug

Nezara viridula attacks leaves; causing tissues to turn yellowish and often leaving patches as a result of feeding punctures. The bug sucks sap from young plants and grain at the soft dough stage, but incidence remains only about 10%, as shown in Table 12c. The use of insecticides is both impractical and uneconomical because traditional tall bulrush millet varieties that are grown by communal farmers are used for subsistance only.

Carbaryl 85 w.p. may be used to kill the pest when the incidence is severe.

Termites

Termites species such as Hodotermes and Macrotermes were observed attacking bulrush millet plants and their incidence was 20 to 30% in Regions III, IV and V. Symptoms may be confused with those of stem-borers at the initial stage of infestation as the central shoots wilt and die due to root severence. This leads to lodging and, once the plants have been cut and fall to the ground, they become covered by soil workings and are ultimately consumed.

It is unfortunate that aldrin and dieldrin in both dust and wettable powder forms are still in use for the control of termites despite their high persistence in the soil. Neither of these insecticides should be recommended to communal farmers. Termite mounds may be eradicated by introducing methyl bromide into the air channels which must be subsequently sealed. During the survey communal farmers did not appear to be paying any attention to termite control, despite the severity of the damage.

Blister Beetles

Blister beetles, Mylabris spp., feed on pollen and directly affect the filling of grain. Large numbers of beetles in a field may lead to a considerable reduction in yield but loss is often insignificant. Infestation was 10% in Regions IV and V. It is difficult to control this pest with insecticidal sprays as the beetles are very active.

American Bollworm

Heliothis armigera, the american bollworm incidence was 20% in Regions IV and V but it can be higher than was observed during the survey, when yield can be reduced considerably. The larvae of *H. armigera* feed on the developing grain, but cut it into bits. Although most larvae are exposed, partial burrowing and tunnelling are common place. Larvae also feed on the leaves, giving them a ragged appearance, and webbing is often present in the panicles. Fortunately this is an occasional pest, although it may cause appreciable loss to newly introduced varieties with compact heads (Gahukar, 1984).

Although no chemical is registered for *H. armigera* control on bulrush millet, carbaryl 85 w.p. may be used with satisfactory results in cases of severe infestion. Few communal farmers pay particular attention to the control of the american bollworm on bulrush millet. This is probably because it is uneconomical and impracticable to use insecticides on tall millet varieties. Since compact headed varieties are more susceptible to *H. armigera* infestation, the growing of less compact headed varieties is highly recommended.

Armoured Crickets

Armoured crickets, *Acanthoplus* spp. and *Enyaliopsis* spp., were observed attacking bulrush millet in Regions IV and V and infestation ranged from 30 to 90%. Infestation in Hwange was as high as 100%. Besides damaging leaves, these crickets can destroy grain at the soft dough stage with resultant severe losses in yield. Crickets are a periodic pest of bulrush millet but are capable of destroying the whole crop when outbreaks are heavy.

Carbaryl 85 w.p. has been used to control this pest in Hwange with unsatisfactory control results. Communal farmers indicated that the common method used in attempting to control the menace of crickets occurring in large numbers is to beat them with sticks though it is unsatisfactory and time consuming. Clearly the control of these pests needs urgent attention by crop protectionists.

TABLE 12c. Insect Pests of Bulrush Millet. The incidence and severity of damage estimated are designated by a score between zero and ten (0, no incidence; 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 7 - 8, high incidence; 9 - 10, very high incidence). Roman numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Stem borers	Busseola fusca Sesamia calamistis Chilo partellus	0	2	2	3	3	2
Maize aphid	Rhopalosiphum maidis	0	0	2	3	3	3
Sorghum aphid	Melanaphis sacchari	0	0	2	3	3	4
Termites	Macrotermes spp. Hodotermes mossambicus	0	0	3	2	2	5
Elegant grasshopper	Zonocerus elegans	0	0	2	2	2	7
Green stink bug	Nezara viridula	0	0	1	1	1	8
Blister beetles	Mylabris spp.	0	0	0	1	1	10
American bollworm	Heliothis armigera	0	0	0	2	2	6
Armoured crickets	Acanthoplus spp. Enyaliopsis spp.	0	0	0	3	9	1
Cotton stainer	Dysdercus sp.	0	0	1	1	1	9

PLATE 2

a. Chlorosis and stunting of sorghum due to *Pratylenchus zeae*, Mutema.

b. Chlorosis and severe stunting of bulrush millet due to *P. zeae* and *Histotylenchus* sp., Mutema.

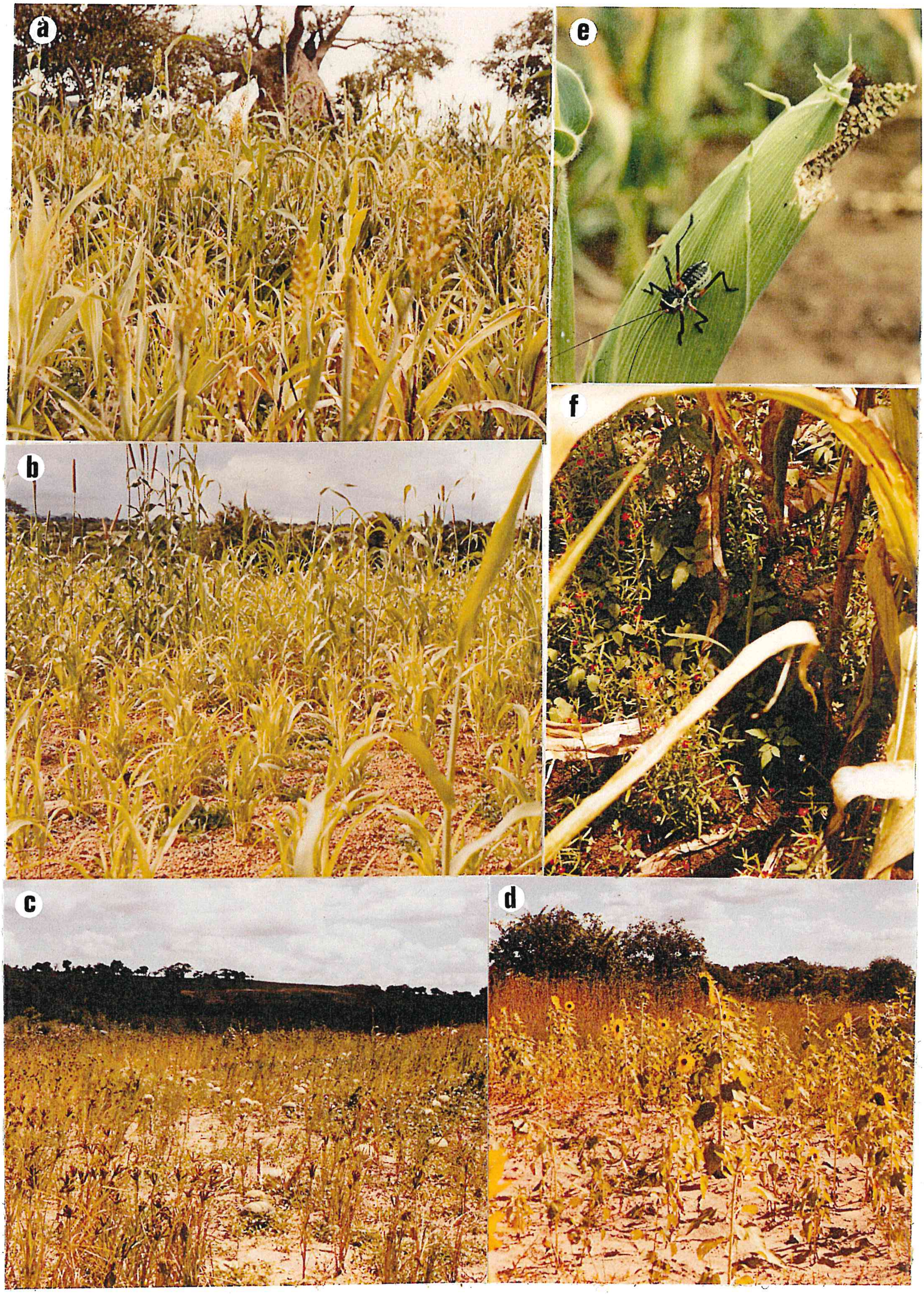
c. Patch of stunted finger millet associated with *Meloidogyne javanica* (32 females per gram of root) (note presence of melon as an intercrop), Mazvihwa.

d. Severe stunting of sunflower due to *M. javanica* (222 females per gram of root), Mberengwe.

e. Armoured cricket damage to maize cob, Hwange.

f. Heavy infestation of witch-weed, parasitic on maize, Tamandayi.

Plate 2



5. GROUNDNUT

The cultivation of groundnut, Arachis hypogea has dramatically declined since the early 1960's. This is said to have been due to the low price that was being offered to growers. Consequently it has been relegated to the status of a "woman's crop" and its cultivation confined to small strips of land between the more important crops. Experts in child nutrition have blamed the increase in malnutrition among children, under the age of five, on a lack of oil in their diet, much of which used to come from traditional peanut butter.

Fortunately this situation is likely to change with groundnut being grown more widely as a result of the recent 50% increase in the price paid to the farmer for this crop. This is good news for crop protectionists also as groundnut is not adversely affected by many of the pests and diseases of the local cereal crops.

Nematode Pests of Groundnut

Nematodes associated with poor growth of groundnut were Telotylenchus obtusus, Paratrophurus sp., Scutellonema spp. and Xiphinema sp. These nematodes were only ever present in low numbers and any damage being caused appeared to be insignificant. None of the important nematodes pests of maize such as Pratylenchus spp., Rotylenchulus parvus or Paralongidorus sp. was extracted from the groundnut samples, which suggests that groundnut is a non-host for these pests. If this proves to be true, groundnut would be an excellent crop to rotate with maize as it would effectively reduce the populations of the above parasites. The communal farmer could thus expand the amount of land under groundnut with confidence, knowing that the return will not only be favourable in financial terms but also in terms of future improvements in the growth of his maize.

Diseases of Groundnut and their control

Leaf Spot Disease

Cause: *Cercospora* spp.

The most widespread and common diseases of groundnut in all regions are the leaf spots caused by two species of the cercospora fungus, *C. arachidicola* and *C. personata*. *C. arachidicola* appears earlier in the season and *C. personata* later.

Symptoms: Leaf spots caused by the two species of *Cercospora* may be distinguished by examining the lower surfaces of affected leaves where *C. arachidicola* produces a light brown spot and *C. personata* and almost black lesion. Both spots are roughly circular with *C. personata* producing slightly smaller spots than *C. arachidicola*. Very often both species may be found on the same leaflet particularly later in the season. Both fungi cause defoliation, the severity of which depends on the groundnut variety, weather conditions and the previous cropping. Upper leaf surface symptoms of the two species are difficult to differentiate.

Control: Carbendazim (Derosol 20%) @ 75 to 1000 mls/ha 21 (days) F.C.S. Repeat at 14 to 21-day intervals.

Chlorothalonis (G) (Daconil) @ 1.5 kg/ha F.C.S. in suitable volume of water. Repeat at 7 to 10-day intervals as necessary for 35 days.

Mancozeb (G) (Dithane M45) 200 g/100 litres. F.C.S. Repeat at 7 to 10-day intervals for 21 days.

Maneb (G) (Maneb) 200 g/100 litres water. F.C.S. of up to 2000 l/ha. Repeat at 7 to 14-day intervals for 21 days.

Propineb (G) (Antracol) @ 200 g/100 litres water. Adjust volume F.C.S. using 500 to 2000 l/ha. Repeat at 14-day intervals for 21 days.

For cultural control groundnut should not be grown more often than one year in four. Early planting is advised. Clean cultivation of land and the removal of volunteer plants during the dry season is recommended.

Rosette Disease

Cause: Rosette virus

Symptoms: Affected plants are yellow in colour and stunted. The leaves may be yellow or mottled and are distorted, the crown does not grow up and the plant is flattened. Plants fail to form nuts after they become infected. An estimate of up to 20% yield loss can be caused by this pathogen.

Control: Use resistant varieties: Eliminate vectors of the virus using pesticides, (see overleaf).

TABLE 13b

DISEASES OF GROUNDNUT

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Cercospora sp.	small, irregular, round white spots with purple margins on leaves	60-70	60-80	40-50	40-50
Phoma arachidicola	leaf blotches	40	50	20	-
Aspergillus flavus	pod rot	-	20	10	-
Rosette Virus	severe stunting; light green or yellow green leaf mottle with distortions	-	-	10	-

Insect Pests of Groundnut and their control

In the field groundnuts are attacked by a number of insects including the groundnut aphid, *Aphis craccivora*; groundnut hopper; *Hilda patruelis*; termites, *Macrotermes* spp. and *Hodotermes mossamibicus*; Coreid bugs such as *Anoplocnemis curvipes*; grasshoppers eg. *Cyrtacanthacris aeruginosa* and *Zonocerus elegans*; white grubs, *Eulepida* spp.; blister-beetles, *Mylabris* spp. and leaf hoppers, *Empoasca* spp. All these insect pests were observed on groundnut in communal farmers fields and are summarised in Table 13c.

Groundnut Aphid

The groundnut aphid, *A. craccivora*, pierces and sucks sap from groundnut leaves. In large numbers this aphid may retard plant growth and wilting is evident in severe attacks. Another symptom is the incidence of sooty mould which was seen on a number of groundnut crops in the communal areas. Aphid populations on groundnuts do not usually reach a level that affects yields substantially. *A. craccivora* is an important vector of the virus disease known as rosette of groundnut. The symptoms of the disease in its severest form comprise stunted growth and chlorosis of the leaves. The disease may cause substantial reduction of yield especially in poor stands of groundnuts. Plants which are affected seldom produce any pods. Incidence was 10% in Region V and 20% in Regions III to V.

Early planting of a good stand of groundnut minimises the chances of the aphid infestations building up before plants are well established. Weed hosts and volunteers should be destroyed well in advance of the planting date. All rosette infested plants should be removed and destroyed to prevent them from becoming a source of new infection. Demeton-S-methyl, dimethoate, endosulfan and monocrotophos are registered insecticides that may be used for aphid control on groundnuts. Few communal farmers will be able to afford to purchase these insecticides and in addition they should not be recommended for use in the absence of Agritex personnel. Communal farmers are keen to protect their groundnut crops against insect damage because they are becoming a popular cash crop once more.

Groundnut Hopper

Hilda patruelis is a groundnut pest of great economic importance in the communal areas, where incidence was 20% in Regions IV and V and 30% in Region I. When an affected groundnut, is closely examined, large numbers of black ants can be seen around the base of the stem. Pulling out such a plant reveals hopping plant bugs amongst the disturbed soil. Loss in yield can be as high as 70% in cases of high infestation (Broad, 1966).

Since *H. patruelis* infestations are haphazard, control is not easy. By the time symptoms of damage are obvious, it is too late to save the affected plants. No chemical has been proved to be effective in controlling *Hilda* infestations but monocrotophos has been registered. This chemical should not be recommended for use by communal farmers unless application is carried out by trained personnel. Practising crop-rotation and keeping the field free from weeds can satisfactorily minimize the impact of this pest.

Grasshoppers

Grasshopper species observed on communal farms visited were: *Zonocerus elegans*, *Cyrtacanthacris aeruginisa* and *Cryptostephanus* sp. The incidence of these grasshoppers ranged from 10 to 20%. Grasshopper infestations were generally low and the effect on yield was expected to be insignificant.

The Green Stink Bug

Green stink bug, *Nezara viridula*, attacks leaves, causing tissues to turn yellowish, leaving patches resulting from feeding punctures. Incidence was about 10% and in most affected fields there was no cause for alarm.

Blister Beetles

Blister beetles, *Mylabris* spp. are common on groundnuts as they are often seen hovering over flowers on which they feed. This feeding activity leads to considerable crop damage. Large numbers of beetles in a field may lead to a total crop loss. Infestation was about 10% in Regions IV and V, 30% in Region I and 40% in Region II.

It is not easy to control blister beetles because they are active fliers. Beating them with sticks may be helpful if the infestation is low but high incidence could be controlled by spraying with carbaryl 85 w.p. Unfortunately insecticidal application is often uneconomic. Carbaryl will also control any N. viridula infestations which warrant spraying.

Leaf Hoppers

Leaf hoppers, Empoasca spp. are very small, wedge-shaped insects which may occur in high numbers on groundnut crops. They shelter on the underside of leaves and are generally seen taking swift brief flights away from plants when disturbed. Incidence in the communal areas ranged from 10 to 20% but heavy infestations can seriously reduce yields. The symptoms of attack are caused by the toxic saliva of the pest. The leaves become pale green or yellowish while their downward curled edges become reddish brown. The impact of attack on yield is generally low so that chemical control is unnecessary.

White Grubs

White grubs are an important pest of groundnuts. They are immature stages of chafer beetles such as Eulepida mashona. These grubs eat the root system of groundnuts beneath ground level and this causes wilting of plants. Crops fertilized with manure (as is often the case in communal areas) are subject to severe white grub attack, as the manure encourages the grub population to thrive.

Weed control, crop rotation and light applications of manure are satisfactory measures for the control of white grubs on groundnuts. Communal farmers were not aware of the havoc which can be made of their groundnut crops by white grubs.

Termites

Termites were observed causing damage to groundnut during the survey. This termite damage is often not appreciated by communal farmers until they are shown the mouldy kernels caused by a fungus which is associated with the activities of these insects. Termites of the *Hodetermes* and *Macrotermes* spp. attack groundnuts at any stage of development. Drought stricken plants are very susceptible to damage by termites. During the survey it was noticed that very few communal farmers were controlling the damage caused by termites to groundnut pods.

TABLE 13c. Insect Pests of Groundnuts. The incidence and severity of damage estimated are designated by a score between zero and ten (0, no incidence- 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 7 - 8, high incidence; 9 - 10, very high incidence). Roman numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Groundnut aphid	*Aphis craccivora*	2	2	2	2	1	4
Groundnut hopper	*Hilda patruelis*	3	4	3	2	2	1
Termites	*Macrotermes* spp. *Hodotermes mossambicus*	2	3	3	3	3	4
Coreid bugs (tip wilters)	*Anoplocnemis curvipes*	1	2	3	1	2	5
Grasshopper	*Crytacanthacris aeruginosa*	2	1	2	1	1	7
White grubs	*Eulepida mashona*	1	3	2	2	1	5
Blister beetles	*Mylabris* spp.	3	4	3	2	1	3
Elegant grasshopper	*Zonocerus elegans*	2	2	2	1		7
Long-horned grasshoppers	*Cryptostephanus* sp.	1	2	1	0	1	10
Leaf hoppers	*Empoasca* spp.	1	0	2	2	2	7
Green stink bug	*Nezara viridula*	1	1	1	1	1	11

6. VEGETABLES

Almost every subsistence farming family in the communal sector cultivates a small vegetable garden. This garden is usually situated in a position which has access to water during the dry season. A vlei,which is a low-lying area subject to periodic flooding, often provides the best site. The vegetables that are produced in these gardens provide important nutrients and variety for a diet that has a predominantly carbohydrate content. Hybrid maize (the main staple food) is normally milled to produce a highly refined flour which is low in B vitamins and pellagra is said to be a problem in some areas. Other vitamins, particularly vitamin A can become deficient if the local diet lacks sufficient variety.

Although the production of field crops was taking priority over the production of vegetables during the time of sampling, we were frequently asked by farmers to give horticultural advice and it became clear that this information was not available through extension workers in some areas. A recent report on horticultural research in Zimbabwe highlighted this shortcoming when it was stated that "research into horticultural crops in communal lands would be impossible due to its small-scale nature" and it was suggested that extension officers rather than researchers would better serve the peoples interestsin this respect. Unfortunately few extension officers have received training in horticulture, so the report goes on to advise them not to get involved with horticultural problems but rather concentrate on "more important crops".

In order to prevent malnutrition, it is vital that people living in the rural areas are encouraged to include a range of different vegetables in their diet and not just cultivate horticultural produce for sale in urban areas. It is highly detrimental to the health of a nation if the relative importance of crops is based on their cash return only. Research into improvement of horticultural crops is of equal importance to that into the improvement of field crops.

Nematode Pests of Vegetables and their control

By far the most important nematode pest of horticultural crops are the ubiquitous root-knot nematodes *Meloidogyne* spp. These nematodes, either *M. javanica* or *M. incognita* were found infesting all of the vegetable gardens that were sampled during the survey. Root-knot nematodes are amongst the most damaging of all pests and diseases of vegetables belonging to the Solanaceae, Cucurbitaceae, Leguminosae families. A list of important hosts for *Meloidogyne* spp. in Zimbabwe is given in Table 14a.

This nematode is a sedentary root endoparasite having swollen, mature females which each lay up to 1,000 eggs, either directly into the soil or between the surrounding cortical cells. Once the juveniles have hatched they re-invade the host via the root-tips to feed directly from the phloem, draining the plants of valuable photosynthesates and at the same time causing the cortical cells to enlarge and multiply. The affected roots then take on the characteristic galled appearance which reduces their efficiency in the up-take of water and mineral salts, while the top growth becomes retarded, the leaves chlorotic and wilting and the yield severely impaired. Yield losses are often in excess of 50% and a total loss can result if secondary infection involving *Fusarium* or *Verticillium* follows the nematode invasion.

Unless a strict system of crop-rotation is adhered to, root-knot nematodes will quickly build up to damaging proportions, converting the vegetable garden into a barren patch of land. The crop rotation recommended by Agritex for vegetable gardens is given below;

winter crops

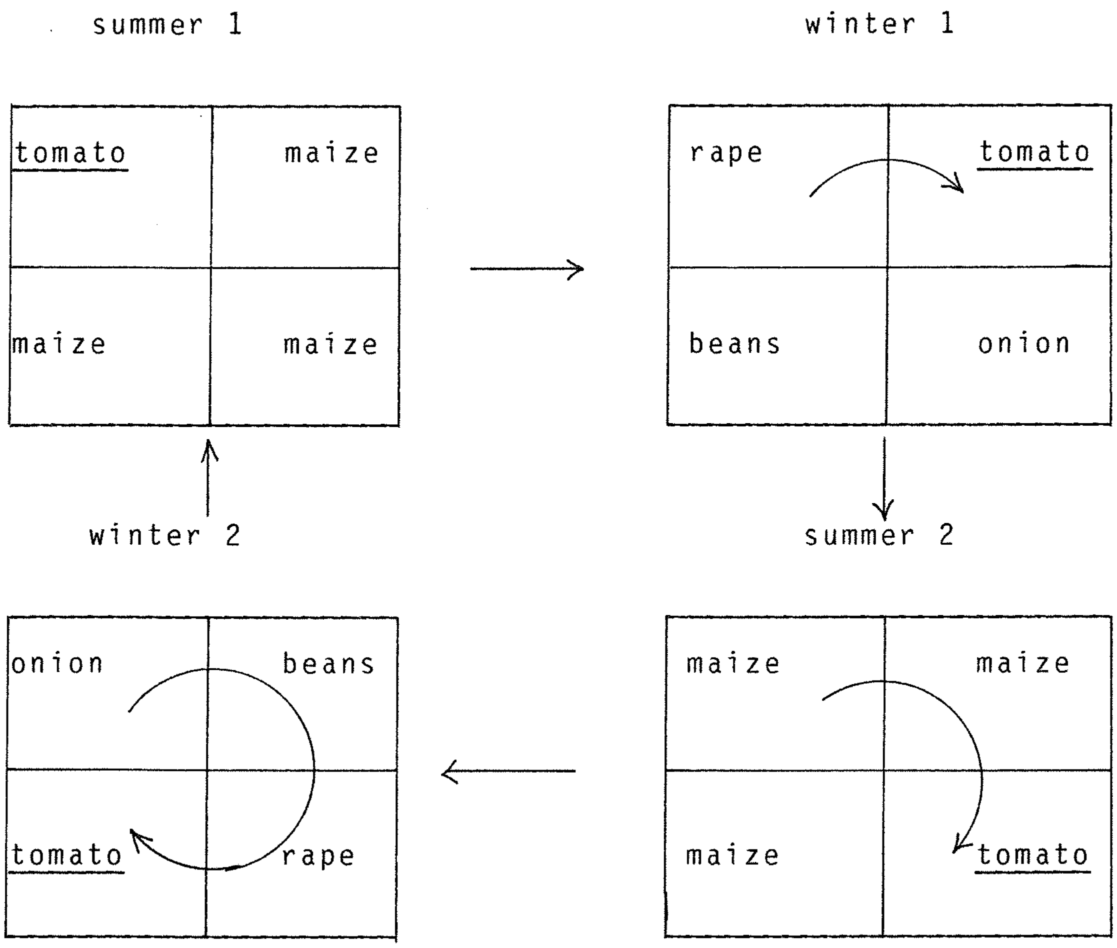
cabbage -> beans -> carrots -> tomatoes -> onions -> spinach ->

summer crops

maize, intercropped with beans, pumpkin or okra.

While this rotation may be useful from an agronomic point of view it is completely useless for controlling root-knot nematodes, as most of the crops are highly susceptible to this pest (see Table 14a). In fact if this rotation is followed it will actively encourage the build-up of massive populations of *Meloidogyne* spp., since it is possible that as many as seven susceptible crops will be planted in succession on the same portion of land.

For successful control of root-knot nematodes, a susceptible crop should not be grown more than once in four seasons, with tolerant or resistant crops being grown in between. Tolerant crops are those which are not significantly damaged by root-knot nematode infections and include brassicas such as rape and cabbage. Crops that should be resistant to root-knot nematodes include maize, onion, garlic, leek and sunnhemp. Obviously a great deal of research, involving field trials to determine the host status of all the local vegetables, needs to be carried out before the ideal crop rotation for vegetable gardens can be drawn up. In the meantime the crop rotation given below should be acceptable to most communal farmers and effectively reduce the numbers of root-knot nematodes down to a level which will not seriously damage the susceptible crops.



For this rotation the vegetable garden must be divided into at least 4 beds. (This should be possible even in small gardens.) A separate portion of land should be set aside for crops that have to be raised in seed-beds, as it is very important that seedlings are completely free from nematode infection while they are at their most vulnerable stage of development. Seed-beds should be moved to a new site each year and sterilised. Soil can be sterilised by burning piles of wood on the surface of the prepared bed. The layer of ash that remains may be removed to the compost heap. Alternatively, when there are cloudless skies, solar power can be used to sterilise seed-bed soil. For this method a 0.04 mm thick, transparent, polythene sheet is required. Firstly, the prepared seed-bed should be irrigated, then the polythene sheet spread over the surface of the soil so that the edges overlap. These edges must be dug into the ground and sealed with soil and stones. The seed-bed should be left in this condition for 4 to 8 weeks or until the temperature in the upper 3 cm of soil has exceeded 60 °C on five consecutive days.

Soil that has been sterilised according to one of these methods will be free, not only from nematode pests but also from weeds, fungal diseases and other soil pathogens. Seedlings that have been raised in sterilised seed-beds will be healthy and thus more likely to tolerate any nematode attack once they are planted out. Flooding to a depth of 1 metre for at least three months also kills off vegetable root-knot nematodes, by causing an anaerobic environment to develop. Thus a vlei soil often makes a good site for a vegetable garden.

Fruit trees such as banana and paw-paw should not be planted in vegetable gardens as they are very susceptible to root-knot nematodes and will, therefore, provide a constant source of infection for the surrounding annual crops.

TABLE 14a

IMPORTANT CROPS THAT ARE HOSTS FOR ROOT-KNOT NEMATODES (*Meloidogyne incognita* and *M. javanica*) IN ZIMBABWE

Banana	*Musa* spp.
Bambara groundnut	*Voandzeia subterranea*
Carrot	*Daucus carota*
Common bean	*Phaseolus vulgaris*
Cow pea	*Vigna unguiculata*
Cucumber	*Cucumis sativis*
Finger millet	*Eleusine coracana*
Eggplant	*Solanum melongena*
Gourd	*Momordica charantia*
Lettuce	*Lactuca sativa*
Melon	*Cucumis melo*
Okra	*Hibiscus sabdariffa*
Paw paw	*Carica papaya*
Peas	*Pisum sativa*
Potato	*Solanum tuberosum*
Pumpkin	*Cucurbita* sp.
Soybean	*Glycine max*
Sunflower	*Helianthus annuus*
Sweet potato	*Ipomoea batatas*
Tobacco	*Nicotiana tabacum*
Tomato	*Lycopersicon esculentum*

Diseases of Tomato and their control

Wilt Disease

Cause: *Fusarium oxysporium*

This is one of the most prevalent and damaging diseases of tomato wherever they are grown intensively. Great losses may be caused by the disease in susceptible cultivars especially when root-knot nematodes are involved. Fusarium wilt causes stunting of plants which soon wilt and finally die. Symptoms: The first symptoms are slight vein clearing on the outer younger leaflets, followed by epinasty of the older leaves caused by drooping of the petioles when plants are infected at the seedling stage. They usually wilt and die soon after appearance of the first symptoms. Older plants in the field may wilt and die suddenly if the infection is severe and the weather conditions favourable for the pathogen. More commonly, however, in older plants vein clearing and leaf epinasty are followed by stunting of the whole plant, yellowing of the lower leaves, occasional formation of adventitious roots, wilting of leaves and young stem, defoliation, marginal necrosis of the remaining leaves and finally death of the plant.

Often these symptoms appear on only one side of the stem and progresses upwards until the foliage is killed and the stem dies.

The fruit may occasionally become infected and then it may rot and drop off without becoming spotted. Roots also become infected particularly if they are already infested with *Meloidogyne* spp. and after an initial period of stunting the smaller secondary roots rot. In cross sections of the stem near the base of the infected plant a brown ring is evident in the area of the vascular bundles and the upward extent of the discolouration depends on the severity of the disease.

The pathogen overwinters in the soil as mycelium and/or any of its spore forms but most commonly as chlamydospores. It spreads over short distances by means of water and contaminated farm equipment and over long distances primarily in infected transplants or in the soil carried with them.

Control: Use of tomato varieties resistant to the fungus and the elimination of root-knot nematodes is the only practical measure for controlling the disease in the field. The use of healthy seed and transplants is of course mandatory and hot water treatment of seed suspected of being infected should precede planting.

Chemical - Copper oxychloride.

Leaf Spot Disease

Cause: *Septoria lycopersici*

The disease can attack at any stage in the growth of the tomato plant and at first may be confused for several other diseases such as *Alternaria* (leaf blight) *Stempyhlium* (leaf spot) and Bacterial leaf spot.

Symptoms: Leaf spots first appear as small yellowish specks that later enlarge, turn pale brown or yellowish-grey and finally dark brown, usually surrounded by a narrow yellow zone. When fully developed the lesions have a greyish centre in which minute black dots may be seen.

Infection usually progresses up the plant from the lower leaves. Although the spots do not coalesce, the leaves eventually wither and die. The fruits are not affected by this disease.

Control: Disease free tomatoes depend on the use of disease-free seed in a field free of the pathogen. Two to three year crop-rotations, sanitation by ploughing deep to cover plant refuse, use of resistant varieties and chemical sprays of the plant in the seed-beds and in the field.

Chemicals - Captafol; Copper Oxychloride; Mancozeb (Dithane M45); Maneb; Metiram (Polyram combi); Sulphur mancozeb (Flower power); Zineb (Lonacol).

TABLE 14b(i)

DISEASES OF TOMATO

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Septoria lycospersici	leaf spots	80	15	-	-
Phytophthora infestans	brown to purple-black lesions on leaves and stems	50	-	30	-
Alternaria solani	dark brown to black oval/angular spots on fruits & leaves	-	-	-	-
Fusarium oxysporium	chlorosis & wilting of leaves with browning of vascular tissue	-	10	10	15
Rhizoctonia solani	damping off of seedlings	-	3	10	-

Diseases of Irish Potatoes and their control

Late Blight Disease

Cause: *Phytophthora infestans*

Symptoms: Appear at first as circular or irregular water soaked spots usually at the tips or edges of the lower leaves. In most weather the spots enlarge rapidly and form brown, blighted areas with indefinite borders. A zone of white downy fungus growth 3 to 5 mm wide, appears at the border of the lesions on the lower surfaces of the leaves. Soon the entire leaflet and then all the other leaflets of the leaf become infected, die and appear limp. Under continuously wet conditions, above the ground parts of the plant blight and quickly rot away, giving off a characteristic odour.

Affected tubers at first show more or less irregular purplish black or brownish blotches. When cut open the affected tissue appears water soaked, dark, somewhat reddish brown and extends 5 to 15 mm into the flesh of the tuber. Later the affected areas become firm and dry and somewhat sunken. Such lesions may be small or may involve almost the entire suface of the tuber without spreading deeper into the tuber. The rot, however, continues to develop after the tubers are harvested. Infected tubers may be subsequently invaded by secondary fungi and bacteria causing soft rots and giving the rotting potatoes a putrid offensive odour.

The development of late blight epidemics depends greatly on the effect of humidity and temperature on the different stages of the life-cycle of the fungus. The fungus sporulates most abundantly at relative humidity of or near 100%.

Control: Sanitary measures, resistant varieties and well-timed chemical sprays. Potato dumps or cull piles should be burned before planting time or sprayed with strong herbicides to kill sprouts or green growth.

Chemicals - Mancozeb (dithane M45); Captafol; Chlorothalonil; metiram; zineb.

Early Blight Disease

Cause: *Alternaria solani*

Symptoms: The leaf spots are generally dark brown to black, often numerous and enlarging, usually developing in concentric rings from which the centres are lost giving them a shot-hole appearance. Lower, senescent leaves are usually attacked first but the disease progresses upwards and changes affected leaves into a yellowish, senescent condition when they either dry up, droop or are shed. On potato tubers, dark, slightly sunken, circular or irregular lesions develop that may be up to 20 mm in diameter and 5 to 6 mm in depth.

Conditions favourable to disease development are humid weather and any factors that reduce plant vigour.

Control: Primarily through the use of resistant varieties of disease free or treated seed and through chemical sprays with fungicides such as chlorothalonil, captafol, zineb and propineb.

Common Scab Disease

Cause: *Streptomyces scabies*

Symptoms: Common scab of potatoes is observed mostly on tubers. At first they consist of small brownish, and slightly raised spots but later may enlarge, coalesce, and become very corky. Frequently the lesions extend below the tuber surface and when the corky tissue is removed, 3 to 4 mm deep pits are present in the tuber. Sometimes the lesions appear as small russetted areas and are so numerous that they almost cover the tuber surface or they may appear as slight protuberances with depressed centres covered with only a small amount of corky tissue.

The pathogen is spread through soil, water, wind blown soil, and on infected potato seed tubers. The severity of potato scab increases when the pH of the soil lies between 5.2 to 8.0. The disease develops most rapidly at soil temperatures of about 20 to 22 C but it can occur between 11 and 30 C.

Potato scab incidence is greatly reduced by high soil moisture during the period of tuber initiation and for several weeks afterwards.

Control: Distribution of scab - free seed potatoes or through seed treatment with maneb - zinc dust or P.C.N.B. If the field is already infested with the pathogen, a fair degree of disease control may be obtained by using certain crop rotations, holding the soil pH to about 5.3, irrigating for about 6 weeks during early stages of tuber development, or by using resistant or tolerant potato varieties.

TABLE 14b(ii)

DISEASES OF IRISH POTATO

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Phytophtora infestans	rapidly enlarging brown to purplish black lesions on leaflets	-	70	-	-
Alternaria solani	dark brown to black oval/angular spots on leaves	-	60	-	-
Fusarium sp.	tuber rot	-	10	-	-
Streptomyces scabies	scabs on tubers	-	30	-	-

Diseases of Beans and their control

Rust Disease

Cause: *Uromyces appendiculatus*

Symptoms: Tiny-whitish dots develop into the characteristic raised spots on which bear reddish brown pustules appear on the leaves and pods.

Control: Chemical - Mancozeb (Dithane M45); Maneb (Maneb); Pyracabolid (sicarol); Sulphur/mancozeb (Flower Power), if severe use mancozeb, thiram or zineb.Resistant varieties would be useful.

Anthracnose Disease

Cause: *Colletotrichum lindemunthianum*

Symptoms: Dark brown lesions on which pinkish spore masses may appear. Angular spots on veins on lower side of leaf and lesions on stems.

Control: Chemical - Captafol; captan; Metiram (Polyram-combi); Zineb (Lonacol). Cultural - select resistant host varieties.

Bacterial Blight, Common Blight Disease

Cause: *Xanthomonas phaseoli*

Symptoms: First seen as small translucent water soaked spots on leaves. The infection occurs from stomatal invasion by bacteria. However, the intervening tissue may turn yellow and form lesions of various sizes and shapes. Small spots also appear on pods of different ages. On green pods the spots may be water soaked at first and turn reddish with age. Water soaking in spots or streaks may appear on petioles, stems and particularly on the pulvinus of the junction of branch, petiole or main stem. As the disease progresses brownish discolouration of the vascular system may become evident and brownish surface cankers may form on the stem in the vicinity of the first node. As the plant becomes top heavy the stem breaks at the weakened points giving rise to a phase of the disease known as joint rot.

This is favoured by relatively high temperatures. Hosts are the small lima bean, scarlet runner bean, Hyacinth bean and white flowered lupin.

Control: Chemical - copper oxychloride (or Cupravit). Cultural - use of healthy seed in crop rotation (a three year rotation is necessary to destroy over wintering bacteria); resistant varieties.

TABLE 14b(iii)

DISEASES OF BEANS

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Colletotrichum lindemuthianum	dark brown lesions, with pink spores during moist weather; elongate, angular spots on veins of lower leaf. Light brown-pinkish lesions surrounding dark brown to black centre, on pods	30	-	-	-
Elsinoe phaseoli	silvery grey, circular	-	3	3	3
Euromyces appendiculatus	rust	20	-	-	-
Xanthomonas phaseoli	circular reddish brown spots on leaves which develop into large brown lesions	-	4	2	-
Alternaria solani	dark brown to black oval/angular spots on leaves				
Sclerotium rolfsii	stem & root rot with dark brown lesions adjacent to/below soil level	-	5	-	-

Insect Pests of Cowpeas and Beans and their control

It is the general practice for cowpeas and beans to be intercropped with other crops such as cereals. During the survey it was observed that cowpea and bean plants are subject to attacks by blister beetles, *Mylabris* spp.; pod-sucking bugs, *Acanthomina* spp., *Anoplocemis curvipes* and *Nezara viridula*; white fly, *Bemisia tabaci*; leaf-hopper, *Empoasca* sp.; bean fly, *Melangromyza phaseoli* and aphid, *Aphis craccivora*. It was not easy to make an estimate of the incidence of these pests and severity of damage because of the erratic nature of the intercropping system which prevails in the communal areas. When these pests are ranked on the basis of economic importance, the bean fly comes first followed by pod suckers, *Emphoasca* spp. and white flies.

To avoid severe infestations by these pests, communal farmers should be encouraged to grow early maturing varieties and follow normal agronomic practices. Since the system of agriculture is intercropping, in most cases chemical control would be very uneconomical. To control the bean-stem maggot (larva of the bean fly) hilling up around plants helps in minimizing losses (which can range from 50 to 100%) since this operation encourages the production of adventitious roots. Chemical control of the bean fly should be preventative and is achieved by treating the crop with diazinon at 3, 7, 14 and 21 days after germination. Crops planted from February onwards are only slightly affected.

7. SUNFLOWER

Sunflower, *Helianthus annuus*, requires few inputs and is a popular cash crop in some communal areas, particularly those in Farming Regions IV and V such as Gwaranyemba, Mberengwe, Umfuli and Ntabazinduna.

Nematode Pests of Sunflower and their control

Unfortunately sunflower is usually grown in sandy soil where it is highly likely to become seriously infected with root-knot nematodes (*Meloidogyne* spp.). *M. javanica* was found causing serious damage to this crop at several sites which were sampled during the survey. Infested plants were extremely stunted chlorotic with diminutive flower heads (Plate 2d). The roots were galled and harboured up to 222 mature females of *M. javanica* per gram of root.

Sunflower must be rotated with crops which are non-hosts for *Meloidogyne* spp. eg. bulrush millet or the green manure crop *Crotalaria spectabilis* if damage by this pest is to be avoided.

Diseases of Sunflower and their control

Leaf Spot Disease

Cause: *Alternaria helianthi*; *Septoria helianthi*

Leaf spot diseases occur commonly and are widespread in sunflower cultivations on the highveld. The naked eye cannot distinguish between the leaf spots caused by the two leaf spot pathogens, *Alternaria* and *Septoria*.

Symptoms: Leaf spots of different sizes occur as localized angular, dark necrotic (dead) spots on the leaf blade of older leaves. These spots spread over the leaf-blade and are sometimes encircled by a chlorotic band. Some blotches show small black knobs or pycnidia, which are the fruiting bodies of *S. helianthi*. *A. helianthi* and *S. helianthi* also give rise to elongated, dark-coloured blotches or spots on the stem and leaf stalks.

Control: Although leaf spot diseases commonly occur in sunflower crops it is doubtful whether they are of economic significance. The reason for this is that only the younger leaves play an active role in producing food for the sunflower plant, while leaf spot diseases are more restricted to the older leaves. It is, therefore, unlikely that the production potential of infected plants will be much affected, making control unnecessary.

TABLE 15b

DISEASES OF SUNFLOWER

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Alternaria helianthi	lesions with dark margins & indistinct yellow halos, bearing faint grey to brown bloom	30	-	12	-
Cercospora bidentis	leaf spots	50	-	-	-
Erysiphe cichoraceanum	white, becoming grey-tan, powdery mildew on aerial parts	-	3	-	-
Puccinia helianthi	leaf spots & stem break	-	-	15	-

8. COTTON

Cotton, Gossypium hirsutum, is a popular cash crop amongst communal farmers, especially those who inhabit Farming Regions IV and V. This crop has the xerophytic characters which enable it to survive in hot, dry areas and produce sufficient good quality lint to gain a fair profit from the Cotton Marketing Board. More than 40% of Zimbabwe's cotton is produced by communal farmers and much of it fetches a high price on the world market, as it is hand-picked. Unfortunately recent government legislation, which ensures that all children have access to free primary education, has led to shortages of labour during the cotton-picking period. Although cotton production requires no capital outlay for specialised equipment or handling facilities, a range of inputs, including both fertilizers and pesticides, have to be purchased and considerable skill is required before the recommended strategy for pest control can but put into operation. This tends to restrict successful cotton production to farmers holding Master Farmer Certificates and completely excludes it from the poorest farmers.

Nematode Pests of cotton and their control

The reniform nematode, Rotylenchulus parvus was commonly found in cotton fields in the communal areas, affected plants were stunted and chlorotic and in some cases partially wilted. This nematode is known to cause severe damage to cotton plants (Louw, 1981). Reniform nematodes are associated with Fusarium wilt, the incidence of which can be as high as 81% in wilt-susceptible cultivars as compared with 10% where reniform nematodes are not present in the soil (Sasser, 1972). Damaging population levels were being maintained where cotton was being rotated with alternative hosts, such as maize. A poor host such as groundnut, would reduce soil populations of R. parvus and should be included in the rotation.

The lesions nematodes, Pratylenchus brachyurus and P. zeae were recovered from cotton roots at several sites and in all cases the cotton was being cultivated following at least one crop of maize. Chemical control of P. brachyurus gave a 15% increase in cotton in Zimbabwe (Anon., 1971)

Again crop rotation is the only practical solution for the control of root lesion nematodes in communal areas.

Other nematodes listed in Table 16a, i.e. Scutellonema spp., Paratrophurus sp. and Hoplolaimus pararobustus that were found associated with stunted cotton were not thought to be causing significant damage.

Meloidogyne spp. was not found causing damage to cotton plants during this survey although it is known to occur in some commercial farming areas, where losses in excess of 42% have been recorded (Louw, 1981).

TABLE 16a

NEMATODE PESTS OF COTTON

Nematode	Associated Symptoms
Rotylenchulus parvus	chlorosis, stunting
Pratylenchus spp.	chlorosis, stunting
P. zeae	
P. brachyurus	
Scutellonema spp.	chlorosis, stunting
S. brachyurum	
S. magniphasmum	
S. cf. *truncatum*	
Paratrophurus sp.	stunted growth
Hoplolaimus pararobustus	stunted growth

TABLE 16b

DISEASES OF COTTON

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Phyllostica gosspina	leaf spots	10	18	20	20
Alternaria gossypina	light brown rimmed small purple spots, enlarging to form lesions on leaves	14	-	-	-
Cercospora gossypina	light brown circular lesions on lower leaf surface	15	-	-	-

Insect Pests of Cotton and their control

Insect pests observed on farms visited at the time of the survey are depicted with their estimated incidences, in Table 16c. Since cotton is a cash crop fetching a high price, if the grade is good, cotton farmers in the communal areas pay particular attention to pest control.

The Cotton Stainer

The cotton stainers (*Dysdercus* spp.) are of great economic importance to cotton farmers. *Dysdercus* spp. such as *D. fasciatus* and *D. intermedius* feed on the cotton bolls from the time they are about 10 mm in diameter until the time of harvesting. The piercing of the green bolls and the feeding on unripe seeds often leads to boll abortion with consequent yield losses. The process of feeding on green bolls, permits the entry of fungus called *Nematospora* which causes a serious discolouration of the developing lint which then receives a low grade. The *Dysdercus* incidence estimate was 30% at the time the survey was carried out.

Destruction of wild hosts in the vicinity would go a long way towards reducing cotton stainer populations but this is often not practicable if these hosts are many or are large trees. Carbaryl, cypemethrin, decamethrin dimethoate and fenvalerate are some of the chemicals registered for the control of the cotton stainers. The synthetic pyrethroids may be used during the recommended period for cotton spraying. This period excludes the months of June, July and August. The cotton stainers are under the natural control of an insect predator, *Phonoctonus nigrofasciatus*, which mimics its prey.

American Bollworm

Economically, the american bollworm, *Heliothis armigera* is a very important insect pest of cotton which must be controlled if yield losses are to be minimised. It is the caterpillar stage which attacks the green wall of the cotton boll. In high infestations, the american bollworm is capable of destroying the whole crop if no control measures are taken. In the communal areas farmers have a spraying programme but those who cannot afford chemicals have their cotton yields drastically reduced by bollworm damage. Incidence was 30% in Regions II, III and IV and 40% in Region V.

A number of insecticides like carbaryl and the synthetic pyrethroids are effective in controlling *H. armigera*. The fact that this pest penetrates the boll gives it some measure of protection against some insecticides.

Cotton Aphid and Jassids

Aphis gossypiss develops in colonies on new shoots and leaves. Aphids cause stunted growth and puckering of leaves. The honey dew secreted by these aphids attracts sooty moulds which may reduce the value of cotton lint. Aphid infestation was about 20% in Region V and 30% in Regions II, III and IV. Decamethrin, a synthetic pyrethroid, is effective in controlling aphids on cotton. Planting in time and keeping the field weed-free will go a long way towards reducing the menace of aphids.

Jassids, Empoasca spp. were also observed attacking cotton. They feed on the underside of leaves causing leaf curl and premature senescence. This pest also causes stunting of growth in addition to the wrinkling and curling of leaves mentioned above. Incidence of this pest on cotton was 10% in Regions III and IV and 20% in Regions II and V. Control measures mentioned for aphids above also apply in the case of jassids.

Red Spider Mite

Tetranychus spp. is an ubiquitous pest of cotton, with a wide host range. It damages cotton leaves which initially appear yellow on their upper surfaces. This is caused by the pest sucking sap from the lower leaf surfaces which tend to become "silvered". The leaves then show signs of wilting and are soon shed.

Most farmers in the communal areas are familar with Tetranychus spp. and take the necessary precautionary measures to minimise its impact on yield. Incidence was 10, 20, 30 and 30% in Regions V, IV, II and III, respectively. There are several chemicals registered for the control of the red spider mite on cotton but dimethoate is popular with communal farmers. To avoid possibilities of resistance to insecticides, the continuous use of one insecticide should be discouraged. This pest was under good control on most farms that were visited and suppression of yields was unlikely.

White Fly

White fly, Bemisian tabaci infestation causes plant tissues to turn yellowish. The damage is due to the pest sucking sap from young leaves. The nymphs are responsible for most of the damage and sometimes wilting and shedding of leaves occurs with considerable losses in yield. They also cause early leaf senescence, premature boll-opening and ultimately the lowering of lint quality. The pest releases sticky honey dew which coats the leaves and encourages the development of sooty mould. White fly incidence in Regions II to V was about 10% which would have little impact on yield.

White flies are difficult to control but the parasitic wasp Eretmocerus sp. is their natural enemy and could be introduced into communal areas. Dimethoate, decamethrin and cypermethrin are registered for white fly control but the last two chemicals should be used only during the normal cotton spraying period.

Red Bollworm and Pink Bollworm

These bollworms which are larvae of Diparopsis castanea are serious pests of cotton and cause significant losses in yield if fields are not protected. The larvae feed on flower buds or inside bolls where they eat the lint and seeds. The pink bollworm is the most notorious pest of cotton throughout the world.

The incidence of these bollworms ranged from 20 to 30% in the communal areas.

Chemical control of the bollworms is not effective because the eggs and larvae are protected inside the cotton boll. Maintaining a closed season that lasts for about 70 days is probably the best control method.

Other Insect Pests

Other insect pests of cotton observed on communal areas were the elegant grasshopper, Zonocerus elegans, Lycas spp., cotton-stem blister beetles and tip-wilters. These insects had incidences ranging from 10 to 20% and their impact on yield was not significant.

TABLE 16c. Insect Pests of Cotton. The incidence and severity of damage estimated are designated by a score between zero and ten (0, no incidence; 1 - 2, very low incidence; 3 - 4, low incidence; 5 - 6, intermediate incidence; 8 - 8, high incidence; 9 - 10, very high incidence). Roman numerals indicate Farming Regions.

INSECT PEST		INCIDENCE AND SEVERITY OF DAMAGE SCORE					ECONOMIC IMPORTANCE RANK
COMMON NAME	SCIENTIFIC NAME	I	II	III	IV	V	
Cotton stainers	Dysdercus spp.	0	3	3	3	3	2
American bollworm	Heliothis armigera	0	3	3	3	4	1
Elegant grasshopper	Zonocerus elegans	0	1	1	1	1	1
Bug	Lycas spp.	0	2	2	1	1	6
Cotton aphids	Aphis gossypii	0	3	3	3	2	3
Red spider mites	Tetranychus sp.	0	3	3	2	1	4
Cotton stem girdler	Tragiscoschema bertolinii	0	1	1	1	1	1
White grubs	Eulepida mashona	0	2	1	1	0	1
White flies	Bemisia tabaci	0	1	1	1	1	1
Jassids	Empoasca spp.	0	2	1	1	2	6
Red and Pink bollworm	Pectinophora gossypilla	0	2	2	2	3	4
Termites	Macrotermes spp.	0	1	2	2	1	6
Ants	Meranoplus spp.	0	1	1	1	0	15
Blister beetles	Mylabris spp.	0	1	1	1	1	10
Tip wilters	Anoplocnemis curvipes	0	2	2	1	0	

9. TOBACCO

Tobacco, *Nicotiana tabacum*, is a suitable cash crop for communal farmers in Farming Regions I and II. Burley and to a lesser extent, oriental tobacco are the main types grown by small holders and cultivation practices are controlled by the Tobacco Research Board. Only a few tobacco fields were sampled during this survey but the root-knot nematode, *Meloidogyne javanica*, was causing damage in some of them. This was despite the fact that most extension workers are aware that root-knot nematodes are serious pests of tobacco. Affected plants were severely stunted and chlorotic with poor quality, wilting leaves. In all cases the source of infection was traced back to the seed beds which were invariably located in vegetable gardens. Tobacco seedlings should never be raised alongside vegetables as most of them are highly susceptible to *Meloidogyne* spp. and thus create ideal conditions for a massive build-up of these nematodes. Once the tobacco seed beds are moved to a new site they should be sterilized either by burning wood on the surface (see Section D6.) or with EDB, using the method recommended by the T.M.B. It is vital that tobacco seedlings are completely free from root-knot nematode infection when they are planted out. Most small-scale growers were rotating their tobacco with maize - which is effective so long as their maize cultivar is a non-host for *Meloidogyne* spp. (see Section D1.). Rotation with soybean or sunflower should be avoided as they are both hosts for root-knot nematodes.

10. SOYBEAN

Soybean, *Glycine max*, is a cash crop that can only be grown successfully in heavy clay soils so is of limited distribution in the communal areas.

Nematode Pests of Soybean

Soybean can be severely damaged by root-knot nematodes and *Meloidogyne incognita* was collected from a few fields. In one case, 200 mature females were present in each gram of root, even though the soybean had followed two crops of maize. Again the need for resistant maize cultivars is evident.

TABLE 17b

DISEASES OF SOYABEAN

DISEASE	SYMPTOMS	PERCENTAGE INFECTION PER REGION I & II	III	IV	V
Colletotrichum sp.	dark brown lesions, with pink spores during moist weather; elongate angular spots on veins of lower leaf surface; light brown-pinkish lesions surrounding dark brown to black centre, on pods	-	10	-	-

11. SWEET POTATO

Sweet potato, *Ipomoea batatas*, is grown by many communal farmers during the rainy season. It is a popular food crop which can be cooked and eaten as a snack. It is normally cultivated in elongated beds close to the compound or at the edge of a maize field.

Nematode Pests of Sweet Potato and their control

The root-knot nematode, *Meloidogyne javanica*, was occasionally found infesting sweet potato roots. The most serious infection rate was 24 mature females per gram of root. These roots were slightly swollen and distorted, though not galled in the way that is normally associated with this nematode. The top growth was extremely chlorotic. Significant yield losses can result from heavy infections by *Meloidogyne* spp. but such losses are probably avoided in Zimbabawe's communal areas due to regular relocation of the sweet potato beds. Root-knot resistant cultivars of sweet potato are available in the U.S.A.

Chemical Control of Nematode Pests

Several nematicides are available in Zimbabwe, these include soil fumigants such as ethylene dibromide (EDB) and carbamate pesticides such as aldicarb and carbofuran, which are also insecticidal and available in granule formulation. EDB is used by small-holder tobacco growers for treating seed-beds while the other nematicides are currently used exclusively by the commercial farming sector. As far as communal farmers are concerned the cost of nematicides would normally be prohibitive to all except those who are concerned with the production of the most profitable of cash crops.

EDB can only be successfully applied to small areas of land, such as seed-beds, if soil injector guns are used. For field treatments tractor-drawn applicators are necessary to ensure an even spread of the fumigant throughout the ridges. Although granular nematicides are somewhat easier to apply, their mode of action is complex. For example, the life-cycle of the target nematode may be interrupted for a period of just a few weeks by only the juvenile stages of this nematode, which are free in the soil, being affected by the nematicide. This means that these chemicals must be re-applied once or twice during the growing season. Unless the farmer is aware of the concept of an "invisible" soil-bound pest, s/he is unlikely to be in a position to apply nematicides correctly and may be forced to hand over responsibility for these pest problems to "experts" from commercial companies.

An additional difficulty with granular nematicides which was experienced in the lower Shire Valley of Malawi (a hot, dry region where conditions are similar to those prevailing in Farming Regions IV and V of Zimbabwe) is that of complete chemical inertia due to low soil moisture (Bridge & Page, 1977).

The over-riding reason for not recommending the use of nematicides by communal farmers is safety. All nematicides have a high oral toxicity and, with the exception of carbofuran, a high dermal toxicity also. Already cases of fatal pesticide poisoning are being recorded on a regular basis in Zimbabwe, the majority of patients being farm labourers from the commercial farms. This problem would certainly increase if communal farmers were encouraged to use nematicides, such as aldicarb or carbofuran, without having easy access to a telephone or clinics staffed by medical personnel who are trained in dealing with cases of poisoning and experienced in administering antidotes. Communal farmers would be at great risk because they would either be unable to read or to carry out the instructions on the label of the pesticide container. Instructions for the safe use of most carbamate compounds advise the user to wear full protective clothing, including gloves, boots and face mask, all expensive items (if they are available) and extremely uncomfortable to wear in the tropics. Storage, disposal and washing of contaminated clothing would pose serious problem in areas where women have to walk several kilometers to the nearest well. The danger to other mammals must also be stressed to farmers with unfenced livestock.

Even if all safety procedures can be satisfied, nematicides can only be recommended for experimental purposes or as part of an "integrated pest control" programme eg. for sterilizing seed-beds, dips for sapling fruit trees or spot treatments of perennial crops. The needs of the subsistence farmer can best be served by a combined effort on behalf of all crop protectionists to establish the most appropriate integrated pest control programme, see section E.

Control of Witch-Weed

Witch-weed, *Striga asiatica*, was seriously suppressing the growth of maize and sorghum in a number of communal areas. This parasitic weed is no longer a problem in commercial farming areas. This is thought to be due in part to the high fertilizer rates which are applied by commercial growers.

The germination of *S. asiatica* is greatly reduced at temperatures below 30 °C, so soil shading by an intercrop such as pumpkin or melon is to be recommended. Zero tillage prevents seed from this weed being incorporated into the soil.* Rotation with cotton or sunflower is recommended by scientists at Henderson Research Station and sunnhemp, *Crotalaria* spp. is said to act as a trap-crop. Some farmers whose fields were choked with witch-weed seemed to be unaware that this weed was responsible for the loss of vigour which was evident in their cereal crop. If communal farmers could be informed of the parasitic nature of witch-weed they may be more inclined to uproot it at, or prior to, the flowering stage, to prevent further seed formation.

* Control of *Striga* and other weeds in Mali by C. Parker, 1984.

E. RECOMMENDATIONS FOR FUTURE WORK

This survey has established that there is an urgent need for research into methods for controlling nematode and insect pests, as well as fungal and viral diseases, and the parasitic weed, *Striga asiatica*. These methods should utilize all the appropriate cultural, biological and chemical techniques to form an integrated control programme which is suited to subsistence agriculture in the communal areas of Zimbabwe, especially those in Farming Regions IV and V. Control methods which are currently being used by commercial farmers are not always applicable to communal areas due to differences in land availability, access to inputs and differing climatic factors.

Communal farmers generally need to grow a much wider range of crops and cultivars to ensure that the maximum natural resistance against pests and diseases is achieved. Long term trials, designed to establish the most effective crop-rotations which will improve soil fertility, prevent the build-up of nematode and insect pests, soil-borne pathogens and witch-weed, should be set up next season.

Increased production of groundnut should be encouraged as this crop is a non-host for most of the pests and diseases which affect cereal crops. The feasibility of incorporating groundnut into a four-year rotation with maize, millet and cotton or sunflower should be investigated. The effect of using a nematode-resistant (and witch-weed resistant?) green manure crop, such as Crotalaria spectabilis or C. juncea, should also be evaluated.

Sorghum and millet are the staple food crops for thousands of people in Farming Regions IV and V and, therefore, deserve to be included in an improvement programme. None of the hybrid maize cultivars that are presently being grown in Zimbabwe have been screened for resistance against any of the specific nematode pests which were identified during this survey. Cultivars of maize, sorghum and millet that are resistant to the root lesion nematode (Pratylenchus zeae and P. brachyurus), maize streak virus, late blight disease (Helminthosporium turcicum), the various smut diseases (Sphacelotheca spp.), rust disease (Puccinia spp.) and if possible stem-borers, (Busseola fusca, Chilo partellus and Sesamia calamistis), should be sought as soon as possible. Field trials to assess the yield losses due to Rotylenchulus parvus, Paralongidorus n.sp., Xiphinema spp., Hoplolaimus pararobustus and Meloidogyne spp., in more precise terms, need to be carried out. Armoured crickets (Enyaliopsis spp. and Acanthoplus sp.) and termites (Hodotermes spp. and Microtermes spp.) were both found to be devastating omnivorous pests in several communal areas and currently cannot be satisfactorily controlled by cultural methods. The feasibility of using bio-control agents should be investigated. Contact has already been made with Commonwealth Scientific and Industrial Research Organisation in Tasmania, in the hope of finding entomophilic nematodes to control stem-borers.

Research into small-scale vegetable production should be given a much higher priority and all local cultivars of the popular vegetable crops should be screened for resistance to root-knot nematodes, in order to establish the most appropriate crop rotation for a small garden.

A programme for future research in plant nematology is set out below:

Pathogenicity studies to establish associated yield losses

1) *Rotylenchulus parvus* as a parasite of maize, finger millet and cotton.
2) *Paralongidorus* n.sp. as a parasite of maize and sorghum.
3) *Xiphinema* spp. as a parasite of maize and sorghum.
4) *Hoplolaimus pararobustus* as a parasite of maize and sorghum.
5) *Meloidogyne* spp. as a parasite of maize and finger millet.
6) *Telotylenchus obtusus* as a parasite of maize and bulrush millet.
7) *Scutellonema* spp. as a parasite of maize and cotton.

Screening Trials to find sources of resistance

1) All cultivars of maize, sorghum, finger millet and bulrush millet for resistance against *Pratylenchus* spp.
2) All cultivars of maize, sorghum, finger millet and bulrush millet for resistance against *Rotylenchulus parvus*.
3) All cultivars of maize, sorghum, finger millet and bulrush millet for resistance against *Meloidogyne* spp.
4) All popular vegetables and their cultivars for resistance against *Meloidogyne* spp.

5) All cultivars of sunflower and soybean for resistance against *Meloidogyne* spp.

Crop-Rotation Trials

1) Effect of different field crop rotations on populations of *Pratylenchus* spp.

2) Effect of different field crop rotations on populations of *Rotylenchulus parvus*.

3) Effect of different vegetable crop rotations on populations of *Meloidogyne* spp.

4) Effect of sunnhemp on populations of nematode pests.

Other Investigations

1) Biological studies of *Paralongidorus* n.sp., including life-cycle, temperature and soil requirements, virus transmission and survival in the absence of a host.

2) Observations on the survival of nematode pests during the dry season.

3) Identification of weeds which are hosts for *Pratylenchus* spp., *Meloidogyne* spp., *Rotylenchulus parvus* and *Paralongidorus* n.sp.

4) Studies on possible interaction between *Rotylenchulus parvus* and *Striga asiatica*.

REFERENCES

ANON., 1971. Report of the secretary for agriculture, Rhodesia, for the period 1st Oct. 1965 to the 30th Sept. 1966. p.27.

BRIDGE, J. & PAGE, S.L.J., 1977. An assessment of the importance and control of plant-parasitic nematodes in Malawi. Report of the Ministry of Overseas Development. 80 pp.

BROAD, G.H., 1966. Groundnut pests. Rhodesian agric. J. 63 (5), 114-117.

DASGUPTA, D.R.; RASKI, D.J. & SHER, S.A. A revision of the genus *Rotylenchulus* Linford & Oliveira, 1940 (Nematoda: Tylenchidae). Proceedings of the Helminthological Society of Washington 35 (2), 169-192.

FLEGG, J.J.M., 1967. Extraction of *Xiphinema* and *Longidorus* species from soil by a modification of Cobb's decanting and sieving technique. Ann. appl. Biol., 60, 429-437.

FURSTENBURG, J.P., 1974. The effect of cultivation on soil nematodes especially *Rotylenchus parvus*. Simposio Internacional (XII) de Nematologia Sciendad Europea de Nematologos, 1-7 Sept, Grenada, Spain.

GUHUKAR, R.T., 1984. Insect pests of pearl millet in West Africa: a review. Tropical Pest Management 30 (2), 142-147.

HEYNES, J., 1966. Studies on South African *Xiphinema* spp., with descriptions of two new species displaying sexual dimorphism of the tail (Nematoda: Dorylaimoidea). Nematologica 12, 369-384.

HEYNES, J., 1979. The genus *Xiphinema* in South Africa. V. *X. zulu* Heyns, 1965 and related species in the *X. hallei* group (Nematoda: Dorylaimida). Phytophylactica 11, 13-22.

LOUW, I.W., 1982. Nematode pests of cotton. *In*: Nematology in southern Africa. Ed. by: D.P. Ketch & J. Heyns. Pretoria, Republic of South Africa; Dept. of Agriculture and Fisheries, 73-79.

MARTIN, G.C.; WAY, J.I. & ARMSTRONG, A.M. Soil fumigation and the control of *Pratylenchus* spp. and other plant-parasitic nematodes affecting maize production in Rhodesia. Presented at the Second Symposium of the Nematological Society of Southern Africa, Stellenbosch, April, 1975.

NORTON, D.C. & HINZ, P., 1976. Relationship of *Hoplolaimus galeatus* and *Pratylenchus hexincisus* to reduction of corn yields in sandy soils in Iowa. Plant Dis. Rep. 60, 197-200.

RENSBURG, J.B.J. van; Walters, M.C.; Stemmet, G.P., 1978. A preliminary study on the application of carbofuran granules to the soil for the control of grain sorghum pests. Phytophylatica 10 (1), 28-30.

SASSER, J.N., 1972. Nematode diseases of cotton. *In*: Economic Nematology. J.M. Webster (ed.) pp.187-214. London: Academic Press.

STIRLING, G.R., 1984. A needle nematode (*Paralongidorus* sp.) causing poor growth of rice in North Queensland. Australian Plant Pathology 13 (2), 22-23.