A REVIEW OF PAST CROP PROTECTION RESEARCH IN THE SOUTHERN HIGHLANDS OF TANZANIA AND PROSPECTS FOR THE FUTURE

L.T.H. Nsemwa, F.M. Mwalyego and D.A. Kabungo

Uyole Agricultural Centre, PO Box 400, Mbeya, Tanzania

ABSTRACT

The Southern Highlands of Tanzania offer favourable climatic conditions, which permit the production of a wide range of crops, making this zone one of the most reliable in terms of food and cash crop production. However, this environment also favours the survival of numerous pests and pathogens which reduce the quantity and quality of crop yields, in addition to increasing production costs of those crops which cannot be produced economically without the use of expensive chemicals. Significant losses occur each year among all food crops grown in the Southern Highlands. For example, more than one-third of the potential production of beans, worth more than TSh 8887 million, is lost in the Southern Highlands each season as a result of disease.

Plant protection research work carried out at Uyole Agricultural Centre (UAC) has concentrated mainly on the control of the major pests and diseases affecting important food crops grown in this zone. Recommendations have been provided for the control of various crop diseases, including anthracnose and angular leaf spot in beans, late blight in potatoes and tomatoes and downy mildew in onions. The control of weevils and nematodes in bananas has also been studied. Research work on field and storage pests has been concerned mainly with maize and beans. Recommendations for pest control have been updated in the light of the new and more potent insecticides available on the market. This paper presents a review of past and ongoing research activities. Current farmer practices and production constraints, as well as future research strategies, are discussed.

INTRODUCTION

The Southern Highlands of Tanzania, consisting of Iringa, Mbeya, Rukwa and Ruvuma Regions, have probably the widest range of cultivated food and cash crops in the country. The economic production of these crops, however, is threatened by the magnitude of pest and disease problems found in this zone, because of climatic conditions which also favour the survival of a wide range of pests and pathogens.

Diseases and pests are important because they reduce the quantity and quality of crop yields. In Tanzania, yield losses due to late blight in potatoes have been as high as 62% (UAC, 1986/87). In beans, losses due to anthracnose have ranged from 27 to 86% (Shao and Teri, 1985) and in maize, losses due to stalk borer damage have ranged from 15 to 30% (UAC, 1982/83, 1985/86). Production per unit area for many crops has continued to be low, especially for those crops which cannot be economically grown without resorting to chemical means of pest and disease control. Without the use of fungicides, for example, coffee berry disease (*Colletotrichum coffeanum* Noak) and coffee leaf rust (*Hemileia vastatrix* Berk et Br.) can easily cause total crop loss under weather conditions favourable for their development. During the 1988/89 season alone, fungicides worth TSh 2,663 million were imported for the control of these diseases (TCMB, 1990).

The objective of this paper is to review disease and pest control research to date for the crops on which work has been done. Measures that the farmers use to control diseases and pests are described, together with the major constraints to the use of control measures. The research needed in future to alleviate farmers' constraints and improve crop production through disease and pest control is then briefly considered.

RESEARCH REVIEW

Surveys have been carried out to identify the main pests and diseases of crops in the Southern Highlands in order to establish their relative importance and to formulate appropriate research strategies for their control. An inventory of crop diseases in the Southern Highlands has been made (Nsemwa, 1982), (Appendix I). Plant protection research activities have been carried out to find means of controlling the pests and diseases of economic importance for some of the crops grown in the Southern Highlands, and some useful findings and recommendations have resulted from this effort.

Diseases control

Beans. Beans are attacked by numerous diseases, the most important ones being anthracnose, (*Colletotrichum lindemuthianum* (Sacc. Magn.) Scrib.) angular leaf spot (*Isariopsis griseola* (Sacc.)), rust, (*Uromyces phaseoli* (Rebens) Wint.) and floury leaf spot (*Ramularia phaseoli* (Drummond) Deinghton). Of relatively minor importance are the bacterial pathogens *Pseudomonas phaseoli* and *Xanthomonas phaseoli*, and the fungal pathogen *Elsinoe phaseoli*, the causal agents of halo blight, common bacterial blight and scab, respectively (Table 1).

Although the cheapest and most sustainable method of disease control is the use of resistant cultivars, only 6% of the germplasm acquired and evaluated by UAC has shown resistance to the major bean diseases. Between 1981 and 1992, 428 local and imported lines/varieties were screened for disease resistance. Of these, 60% were resistant to anthracnose, 22% to angular leaf spot and 49% to rust (UAC, 1982-1992). Use is being made of some of these resistant types for breeding purposes.

Cultural methods as a means of controlling seed-borne diseases have also been evaluated. Seed selection (sorting) has been shown to reduce the severity of anthracnose by 27% and angular leaf spot by 33% in susceptible varieties, leading to yield increases of 21 and 32%, respectively (Table 2). By comparison with chemical spraying, seed selection may be a cheap means of reducing the severity of seed borne diseases of beans. Rotating beans with maize has resulted in a 27% reduction in the severity of bean diseases and a 22% increase in yield compared with continuous cropping (UAC, 1989/90). Similarly, combining rotation with seed selection, has resulted in a 41% reduction in the severity of bean diseases, resulting in yield increases of 110%, compared with continuous cropping (UAC, 1989/90).

Table 1. Yield losses from bean diseases in the Southern Highlands of Tanzania

	No. of trials	Yield loss ha^{-1}	Yield loss range (% ha^{-1})	Actual yield reduction (kg ha^{-1})	Equivalent cash loss (TShs ha^{-1})
Anthracnose	10	57	38-100	1017.2	101 720
Angular leaf spot	10	40.6	11-51.3	675.6	67 560
Rust	10	39.4	3.5-70	648.2	64 820
Halo blight	7	29.5	15-54	384.3	38 430
Floury leaf spot	7	38.7	8.3-49	480.2	48 020
Aschochyta blight	8	21.1	3-42	379.8	37 980
Scab	6	33.3	12-59	302.9	30 290
Total	50			3888.2	388 820
Mean	8	37.1		555.5	55 545

Table 2. Effects of seed selection (selected, sel., or unselected, unsel.) and benomyl sprays on bean yield and the incidence of anthracnose and angular leaf spot diseases in two bean cultivars

	cv. Sumbawanga C.[1]			cv. Kablanketi[2]		
	Sel.	Unsel.	Sprayed	Sel.	Unsel.	Sprayed
Germination (%)	92.8	79.7	80.4	91.3	88.0	86.6
No. of infected plants after emergence	11.5	25.0	27.0	6.0	18.0	13.0
Disease severity 6 weeks after emergence (1-9 scale)	5.5	7.5	3.1	5.1	7.6	1.8
Seed quality (1-3 scale)	2.2	2.6	1.0	2.0	2.8	1.0
Yield (kg ha^{-1})	1169.6	930.2	1245.2	1044.2	716.6	1119.8

[1]Anthracnose susceptible; [2]Angular leaf spot susceptible.

The potential of seed mixtures to minimize the risks of severe disease epidemics has been observed by Ayeh (1988, 1990), Altieri (1987) and Ishabairu and Teri (1983). Similar work carried out in the Southern Highlands showed that seed mixtures gave an overall yield increase of 14.5% and a reduction in disease severity of 31.3%, by comparison with pure stands. The severity of bean anthracnose, angular leaf spot and floury leaf spot were reduced by 26, 33, and 18%, respectively, as a result of the use of seed mixtures (Table 3).

Experiments have been carried out to evaluate fungicides for the control of bean diseases. Cost effective control of anthracnose and angular leaf spot has been achieved with the fungicide benomyl 50WP (Shao and Teri, 1985). In recent work, significant yield increases have been achieved with the use of new products: Folicur 250 EC for the control of anthracnose, bean rust and angular leaf spot, and Baycor 300 EC for the control of rust. Both products are currently recommended by UAC (UAC, 1991/92).

Table 3. Yield of six bean mixtures (components mixed in equal proportions) and their respective disease score for anthracnose (Anth.), angular leaf spot (ALS), rust, and floury leaf spot (FSL) (means of three sites)

Bean cultivar/mixture	Disease score (1-9 scale)				Yield (kg ha^{-1})
	Anth.	ALS	Rust	FLS	
SYM (A)	2.7	6.9	1.7	2.1	1118.5
Kabanyolo (B)	4.1	3.3	1.1	4.8	1493.5
YC-2 (C)	2.5	6.5	1.3	2.2	1182.7
Kabanima (D)	1.0	5.4	1.0	3.0	1449.5
Lyamungo 85 (E)	2.8	6.9	1.1	2.3	1262.3
UAC 41 (F)	3.0	4.1	1.2	2.2	1985.6
CG 113 (G)	5.5	2.4	1.1	2.4	1585.4
A + B	2.9	3.8	1.4	2.4	1648.7
C + D	2.5	5.9	1.2	2.2	1492.1
D + E	1.6	4.7	1.1	2.3	1443.9
C + D +E	2.1	5.1	1.3	2.3	1456.0
F + G	2.4	3.9	1.2	2.3	1939.4
A + B + C + D + E + E + G	2.2	5.1	1.9	2.0	1697.6
Mean of sole crops	3.1	5.1	1.2	2.7	1454.8
Mean of mixtures	2.3	4.9	1.3	2.2	1612.9
CV (%)	32.1	22.4	24.5	15.4	

Potatoes. In the Southern Highlands, potatoes are attacked by several diseases: viruses, leaf spot, (*Alternaria solani* Saraeur), black scurf, (*Rhizoctonia solani* Khun), bacterial wilt (*Pseudomonas solanacearum* E.F. Smith), powdery scab (*Spongospora subterranea* (Wallr.) Lagerh) and late blight disease, LBD (*Phytophthora infestans* (Mont.) de Bary). However, late blight is the most important disease and one on which much research effort and many resources have been expended in order to identify resistant varieties and clones.

A highly significant negative correlation (r = -0.72) has been found between yield and the level of late blight attack (Figure 1). Without fungicide protection, yield losses range from 38 to 66%, being much higher in late planted potatoes as a result of more severe late blight disease pressure (UAC, 1981/82). The effect of time of planting on potato yield is discussed under the potato research paper (Mayona and Mwambene, 1992). Production of potatoes under rainfed conditions in the Southern Highlands, therefore, is generally uneconomic in the absence of late blight control, because current potato varieties do not possess adequate genetic resistance to this disease.

Among many fungicides evaluated for the control of late blight, mancozeb, copper oxychloride matalaxyl-mancozeb and copper hydroxide have shown effective control and are currently recommended. Two more fungicides, Antracol 70% WP and Milraz 76% WP, are undergoing evaluation and have shown very promising results (UAC, 1990/91).

Investigations to determine an economic spraying frequency have shown that spraying recommended fungicides twice a week provides adequate control of late blight. Further more, it has been shown that commencing the spraying schedule two weeks after emergence and continuing to spray the sixth or eighth week is more economical than spraying from emergence to maturity, 12 weeks after emergence, since the yields in both cases are comparable (Table 4). If systemic fungicides are used spraying can be reduced to once a week, instead of twice, without a significant reduction in yield.

Table 4. Potato tuber yield (t ha^{-1}) and disease indices for the occurence of late blight (DI, %) under different fungicide spraying regimes at Uyole and Igeri

	Uyole		Igeri
	Yield	DI %	Yield
Unsprayed control	20.4b	34.7	23.3d
Sprayed twice weekly from:			
Emergence to maturity	40.3a	3.6	45.1a
Emergence to 4 wae	37.5	2.6	32.7bc
Emergence to 6 wae	31.5ab	7.1	39.1ab
2 wae to Maturity	40.0a	10.2	40.0ab
2 wae to 6 wae	38.0a	6.6	39.1ab
2 wae to 8 wae	40.7a	7.1	40.7ab
4 wae to 8 wae	34.9ab	16.5	28.9cd
LSD (P<0.01)	13.6	NS	7.9

Wae, weeks after emergence; abcd, data followed by the same column are not significantly different at the 5% level, according to Duncan's Multiple Range Test; NS, not significant

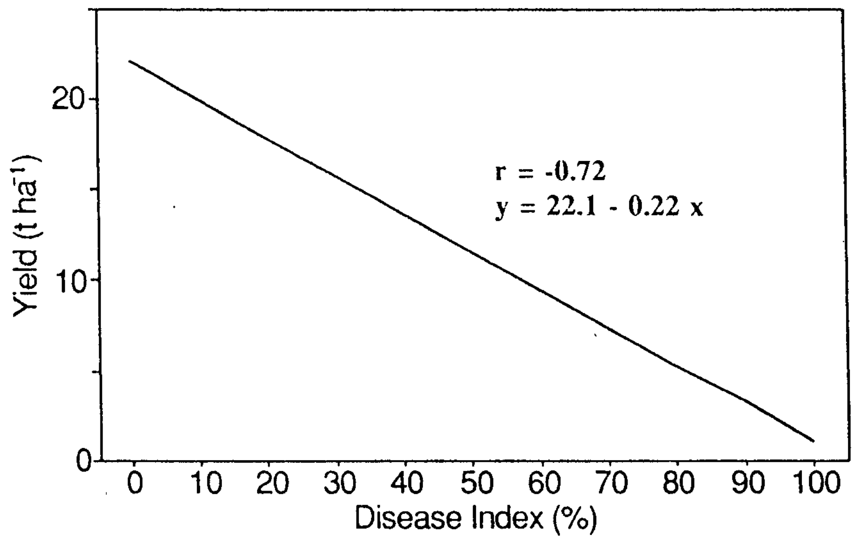

Figure 1. Effect of late blight disease on potato yield at Igeri during the 1979/80 and 1980/81 seasons

Tomatoes. Late blight disease, (*Phytophthora infestans* (Mont.) de Bary) is the most serious disease of tomatoes in the Southern Highlands as well as in other parts of Tanzania. Commercial varieties resistant to this disease are not available. Production of tomatoes is therefore heavily dependent on the use of fungicides, especially during the rainy season when attack by late blight is most severe. Trials carried out in the 1970s recommended the use of mancozeb, copper oxychloride and copper hydroxide (sprayed once or twice a week) for the control of late blight in tomatoes during the rainy season and these chemicals are now widely used (UAC, 1974/75-1982/83). The synergistic interaction of fungicides in the control of tomato late blight observed by Gisi *et al.* (1985) and Samoucha and Cohen (1986), has also been observed at UAC. A combination of metalaxyl and mancozeb was highly effective in controlling late blight when sprayed at a rate of 2.5 kg ha^{-1} once or twice a week (Nsemwa, 1988). The metalaxyl/mancozeb mixture has therefore been recommended for use in tomatoes. In on-going trials, propineb has been as effective as metalaxyl/mancozeb or mancozeb alone in controlling late blight of tomatoes and may soon be recommended.

The cost of fungicide use for late blight control in tomatoes has been evaluated for chlorothalonil (Bravo 500 FW) sprayed once or twice a week compared with an unsprayed check. Use of fungicide for late blight control was found to be profitable, especially when the spraying frequency was limited to once a week (Table 5).

Onions. Downy mildew (*Peronospora destructor* (Berk.) Casp) is the most important onion disease in the Southern Highlands. Purple blotch, (*Alternaria porri* (Ell.) Cifferi) is of less importance. Preliminary trials at Uyole have shown that downy mildew can be controlled by fungicides, such as mancozeb, chlorothalonil and metalaxyl/mancozeb (UAC, 1986/87, 1987/88). Attempts to use liquid soap at different concentrations as surfactants, however, have failed to improve the efficacy of the fungicides. Cultural practices, such as avoiding the growing of onions in areas, or during periods, with cool moist conditions which favour disease development, may minimize the severity of the disease.

Banana. Banana weevil (*Cosmopolites sordidus* (Germar)), root knot and root lesion nematodes (*Meloidogyne sp.*, *Hoplolaimus angustalatus* Whitehead, *Helicotylechus multicinctus* (Cobb) Golden, and *Pratylenchus sp.*) are among the major problems associated with a decline in banana production in the zone (Nsemwa, 1975, Lindqvist, 1981). In addition to use of good crop husbandry, the nematicides/insecticides carbofuran and isazophos have been recommended for control of the banana weevil and nematodes (Bujulu *et al.*, 1982). Currently Nemacur O, a combination of fenamiphos and isophenphos, is being evaluated for the control of these pests (Nsemwa 1991b).

Table 5. An analysis of the cost of fungicide use in tomato production at Uyole using chlorothalonil (Bravo 500 FW)

Fungicide spray frequency	Labour (person days ha^{-1})	Cost (TSh x 10^3)		Yield (t ha^{-1})	Net crop value (TShs x 10^3 ha^{-1})	Value cost ratio
		Fungicide	Labour			
Unsprayed	0	0.0	0.0	2.4	36	-
Once a week	69	80.9	9.8	30.7	334	5.1
Twice a week	121	140.1	17.1	34.9	330	3.3

[1]Price of Bravo 500 FW at TSh 1540 $litre^{-1}$, price of tomatoes at TSh 15 kg^{-1} and wage of Tshs 141.15 person day^{-1} (in 1991/92 300-400 TSh = US$1, very approximately).

Pest control

Maize. Maize (*Zea mays* L.) is attacked by several insect pests in the field as well as during storage. Among those attacking maize in the field, the maize stalkborer (*Busseola fusca*), found in areas lying between 600 and 2700 m above sea level, is the most important, not only in this country but in most African countries south of the Sahara (Walker and Hodson, 1976). It can cause up to 50% crop loss during severe attacks. Other pests include the cutworms (*Agrotis sp.*), armyworm (*Spodoptera exempta*), and the maize seedling weevil (*Tanymecus arushanus*). The seedling weevil can cause up to 60% loss in crop stand (Mallya, 1977). Storage insect pests include the larger grain borer (*Prostephanus truncatus*), the maize grain weevil (*Sitophilus granarius*) and the angoumois grain moth (*Sitotroga cerealella*). The larger grain borer, which is now wide spread, was first reported in the zone in 1985 in Songea and Chunya Districts.

Research activities on field pests have concentrated mainly on the control of stalk borer. Trials carried out in the early 1970s recommended the use of DDT and Endosulfan. Later, DDT was withdrawn and Sumicombi 1.8 and 3% dust and Cypermethrin (in different formulations) were recommended in addition to Endosulfan. Some botanical insecticides, such as Lidupala (*Neuratanenia mitis* and Utupa (*Tephrosia vogelii*) were also identified and recommended.

In an attempt to achieve a more integrated pest control strategy, the life cycle of *Busseola fusca* was studied under conditions in the Southern Highlands (UAC, 1981/82, 1982,83). These studies revealed that proper maize stover management could significantly reduce the population of larvae and pupae, which remain in diapause throughout the dry season, thereby reducing the severity of stalk borer attack in the subsequent planting seasons. Dry maize stover, when slashed and left on the ground, or when slashed and either chopped and left on the ground, or buried, resulted in over 80% mortality of the larvae and pupae (Table 6). Dry maize stover left standing after harvest resulted in much lower larva and pupae mortality. Cutting and/or chopping the dry maize stover after harvesting therefore appears to be a cheap and beneficial cultural practice which could be adopted by farmers to reduce the severity of stalk borer attack.

The method and timing of application of insecticides for the control of stalk borer have also been evaluated (UAC, 1988/89). There was little difference in the degree of control achieved by a particular insecticide whatever the application method used: application of insecticides in dust formulation by hand, as emulsifiable concentrates by knapsack sprayers, use of ultra low volume applicators, or use of the electrodyn formulation. Recent work has shown that stalk borer can be effectively controlled when recommended insecticides are applied once, eight or nine weeks after planting. Previously the recommendation was to apply insecticide six weeks after planting, followed by a second application nine or ten weeks after planting.

The control of armyworm is usually accomplished by monitoring adult moth populations with the aid of pheromone traps located in most parts of the Southern Highlands zone, as part of the nationally co-ordinated pest control service. In the event of potentially damaging outbreaks, Cypermethrin, Fenitrothion and Endosulfan applied as emulsifiable concentrate or ultra low volume formulations are recommended.

Although *Tanymecus* weevils are capable of causing serious damage to maize at the seedling stage, the problem is localized. Serious damage has been reported only in Njombe District and at Dabaga in Iringa District. Biological studies have shown that cultural control measures, such as crop rotation and deep ploughing so as to expose the diapausing larvae and pupae to harsh conditions after the maize harvest, may provide effective control of the weevil. Among chemicals evaluated, Karate emulsifiable concentrate at 500 ml ha^{-1} has given good control and is currently recommended.

Common maize storage pests found in the Southern Highlands were previously controlled by the use of malathion (Kynakil 1% dust), and later by pirimiphos methyl (Actellic 50 EC). However, the occurrence of the larger grain borer in the mid 1980s created serious storage problems, as malathion or pirimiphos used alone could not control it. Traditional maize storage techniques (storing maize on the cob, with the husk intact) appeared to increase the damage done by the larger grain borer. Further screening of insecticides later resulted in the identification and recommendation of Actellic Super Dust (1.6% pirimiphos methyl and 0.3% permethrin) for the control of the larger grain borer and all other common grain storage pests of maize.

Table 6. Effect of different stover management practices on the survival of diapausing maize stalk borer larvae

	Dead larvae (%)[1]	Dead pupae	Dead insects (% of total instars)
Stover slashed, left on ground	75.8a	94.1a	88.3a
Stover left standing	36.8ab	55.4d	48.8c
Stover slashed and burned	15.8b	64.9c	53.2c
Stover chopped, left on ground	86.7a	78.7b	79.5b
Mean	53.8	73.3	67.5
CV (%)	26.2	23.1	22.2

[1]Data were subjected to the square root transformation prior to statistical analysis; abcd, data followed by same letter in the same column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Beans. Among the insect pests attacking beans in the field, the bean stem maggot or beanfly (*Ophiomyia spp.*) is the most important both in the Southern Highlands and in the country as a whole. Of the three species occurring in the country, *O. spencerella* is the most prevalent in the Southern Highlands. During the main growing season at Uyole, bean stem maggots have been most numerous between February and March, resulting in more that 60% crop losses (Figures 2 and 3). The bean aphid, *Aphis fabae*, is another important pest with the potential to cause total crop loss, especially when beans are planted late or out of season. In storage, beans are attacked by the bean bruchid (*Acanthoscelides obstectus*), which is the only important storage pest of beans in the Southern Highlands.

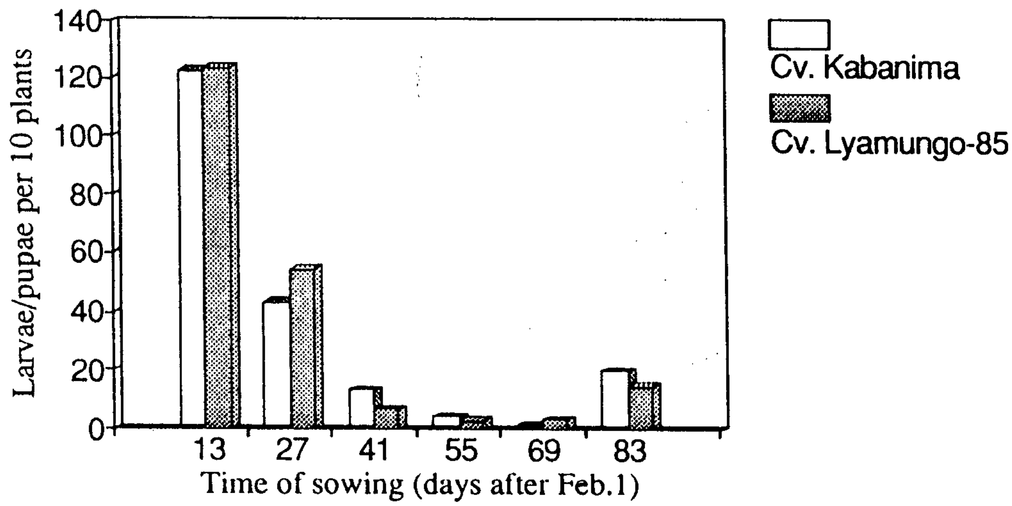

Figure 2. Effect of time of sowing on bean stem maggot infestation (lavae/pupae counts) in two bean varieties

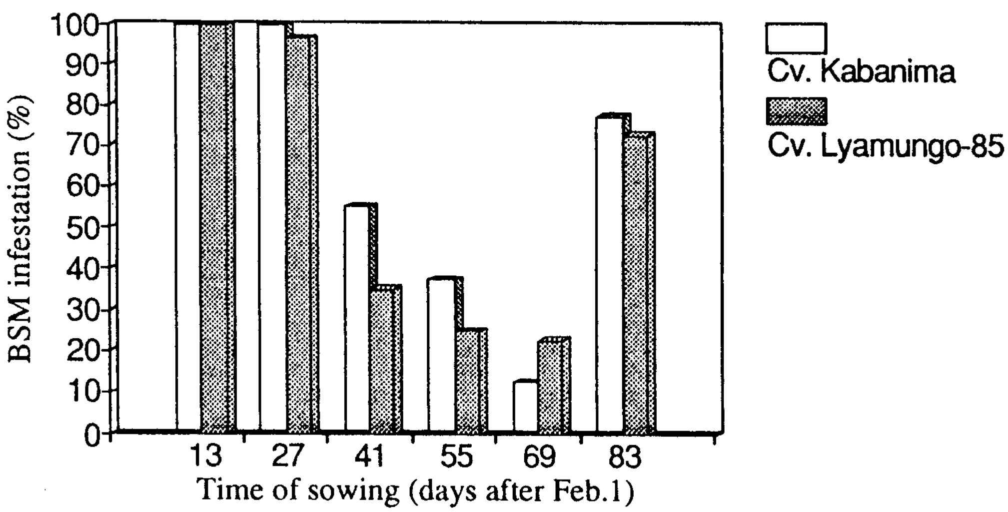

Figure 3. Effect of time of sowing on bean stem maggot (BSM) infestation in two bean varieties

In the absence of resistant varieties, use of chemicals is the most feasible method of pest control. Bean stem maggot has been successfully controlled by Endosulfan and Fenitrothion sprayed within a week of emergence. Seed dressing with Fernasan D (lindane 20% + thiram 25%) at 3.5-4.0 g kg^{-1} seed or Oftanol (Isophanphos), which is a new product, at 2.5-3.0 g kg^{-1} has been very effective. Other insecticides, such as Karate, Danitol S and Fenom P, are suitable substitutes. Tephrosia leaf extract has also shown potential for controlling bean stem maggot when sprayed within one week after emergence at a rate of 300 g 6 l^{-1} of water. Cultural practices, such as planting resistant or tolerant varieties, use of fertilizers, planting to escape peak population periods, and earthing up the plants around the stem, may minimize stem maggot attack on beans.

Cassava. Although in the past cassava has not had serious pest problems, its production was threatened after the presence of the cassava mealybug (*Phenococcus manihoti*) was confirmed along the shores of Lake Nyasa in 1987 and Lake Tanganyika in 1988. Biological means of control were sought during the 1988-89 season, when the parasitic wasp, *Epidinocarsis lopezi*, was introduced into the country from the International Institute of Tropical Agriculture, Ibadan, Nigeria. The wasp was released at Kilosa-Mbambabay, along the eastern shore of Lake Nyasa, as well as in several other cassava-growing areas in the country. Annual surveys to monitor the extent of spread and survival of the wasp indicate that this approach has been successful, especially in areas where significant damage had previously been reported.

Current farmer practices and constraints

Although pest and disease resistant varieties are available, most smallholder farmers prefer to grow their local varieties, which are low yielding and susceptible to the major crop pests and diseases. The rate of adoption of improved varieties is therefore slow. The tendency for farmers to put more emphasis on taste than on yield may be one of the factors limiting the adoption of superior varieties or agronomic recommendations that ensure economic production of the various crops found in the Southern Highlands.

For disease control in beans, potatoes and onions, most farmers plant so that the crops escape peak disease periods. Unfortunately such conditions are also unfavourable for crop development, so that the resulting yields are poor. Despite this approach, seed-borne pathogens continue to be a problem since few farmers carry out seed treatment.

The ready market for tomatoes, onions and potatoes encourages farmers to grow crops at times when they are liable to heavy disease infection, thereby making use of pesticides inevitable if heavy crop losses are to be avoided. However, most pesticides are too expensive for small scale farmers and at times they may not be available when required.

RECOMMENDATIONS FOR THE FUTURE

Research

In future emphasis will be placed on studying the variability of the different bean pathogens with the aim of enhancing the breeding of cultivars for stable disease resistance. More sources of resistance to the major crop disease will be sought. The effects of different cropping systems on the prevalence and severity of diseases of beans, potatoes and tomatoes will also be determined.

Disease and pest surveys will be continued in order to monitor the severity and spread of those already identified as well as new pests and diseases, for example the black leaf streak disease of banana (*Mycosphaerella fijiensis* Morelet) which recently has entered the country (Sebasigari and Stover, 1988; Bujulu *et al.*, 1991) and the Tanymecus weevil which is still localized in Njombe and Iringa Districts.

Fungicide and insecticide screening work will be continued in order to facilitate the updating of pest and disease control recommendations.

Economic control measures will continue to be developed for crop diseases and pests, including those previously considered minor in importance, such as black pod disease in cocoa and pests such as the coffee leaf miner in coffee, the American bollworm and tomato leaf miner in tomatoes, Epilachna beetles in potatoes, and diamond back moth in cabbage. Particular emphasis will be placed on biological control of the cypress aphid (*Cinara cupressi*) which has recently been reported in Tanzania (Kabungo, 1988).

An integrated control strategy for both pests and diseases will be initiated in order to minimize dependence on chemicals, some of which may be hazardous to the environment in the long term in addition to being costly. Use of locally available botanical insecticides, such as Lidupala and Utupa should be encouraged and research in this area will be increased.

Appendix 1. Newly recorded diseases and pests in the Southern Highlands

	Disease/pathogen or pest	Reference
Banana	Root lesion nematodes (*Hoplolaimus* sp., *Pratylenchus* sp., *Helicotylenchus multicinctus*)	Nsemwa, 1975 Lindqvist, 1981
	Leaf eating caterpillars (*Acanthopsyche* sp., *Acrea acerata*)	Nsemwa, 1975
Arabica coffee	Twig dieback (Phoma sorghina)	Nsemwa and Shao, 1990
Silky oak tree	Gumming and dieback (*Cylindrocarpon obtusisporum*, *Botryosphaeria ribis*)	Nsemwa and Shoa, 1990
Beans	Root knot nematode (*Meloidogne iavanica*)	Nsemwa, 1991a
Potato	Root knot nematode (*Meloidogne iavanica*)	Nsemwa, 1991a
Cassava	Mealybugs (*Phenacoccus manihoti*)	UAC, 1987
Cypress	Drying and death of trees (associated with cypress aphid, *Cinara cupressi* Buckton)	Kabungo, 1988

REFERENCES

Altieri (1987). *Agro-ecology - the Scientific Basis of Alternative Agriculture.* Boulder Co., USA: Westview Press.

Ayeh E. (1988). Evidence for yield stability in selected landraces of bean (*Phaseolus vulgaris*). Experimental Agriculture 24:367-373.

Ayeh, E. (1990). Studies on seed mixtures of *Phaseolus vulgaris* L. in Malawi. *Bunda Journal of Agricultural Research* 2:25-36.

Bujulu, J., Cumming, C.N.C., Mallya, G.A., Uronu, B. and Bagonzekwi, J. (1982). The Control of Banana Weevils and Nematodes in Tanzania: An Interim Report of the Banana Weevil and Nematode Control Team. Dar es Salaam: Ministry of Agriculture and Livestock Development.

Bujulu, J., Nsemwa, L.T.H. and Rukazambuga, N.D. (1991). The Banana Sigatoka Disease Problem in Tanzania. Paper presented at the Banana Black Sigatoka Disease Workshop held on 23 January 1991, Zanzibar.

Gisi, U., Binder, and Rimbach, (1985). Synergistic interactions of fungicides with different modes of action. *Transactions of the British Mycological Society* 85 (2):299-306.

Ishabairu, T.R. and Teri, J.M. (1983). The effect of bean cultivar mixtures on disease severity and yield. Paper presented at Bean Researcher's Workshop, UDSM, Morogoro September 6-7, 1983.

Kabungo, D.A. (1988). A preliminary Report on Cypress Aphid in the Southern Highlands of Tanzania. Mbeya, Tanzania: Uyole Agricultural Centre. (Unpublished).

Lindqvist, B. (1981). A Survey of Pests and Diseases of Banana, Citrus, Cocoa and Coffee in Kyela and Rungwe Districts, Mbeya Region, Tanzania, July-August 1980. Uppsala, Sweden: Department of Plant and Forest Protection, Swedish University of Agricultural Sciences.

Mallya, G.A. (1977). Tanymecus weevil on maize in Njombe District. Mbeya, Tanzania: Uyole Agricultural Centre. (Unpublished.)

Mayona, C.M. and Mwambene, R.O.F. (1992). Progress on potato improvement in the Southern Highlands of Tanzania. In *Proceedings of the Conference on Agricultural Research, Training and Technology Transfer in the Southern Highlands of Tanzania: Past Achievements ans Future Prospects* 195-204. 5-9 October 1992, Uyole Agricultural Centre, Mbeya, Tanzania.

Nsemwa, L.T.H. (1975). Pests and Diseases of Bananas in Rungwe District - Tanzania. B.Sc. (Agric.) Special Project, Makerere University, Kampala.

Nsemwa, L.T.H. (1982). List of Diseases of Crops in the Southern Highlands of Tanzania. Mbeya, Tanzania: Uyole Agricultural Centre.

Nsemwa, L.T.H. (1988). Use of metalaxyl/mancozeb for the control of late blight disease in tomato in the Southern Highlands of Tanzania. Paper presented at the National Horticulture Research Coordinating Committee Meeting, Arusha, 2 February 1988.

Nsemwa, L.T.H. (1991a). Some plant parasitic nematodes in the Southern Highlands of Tanzania. *East African Agriculture and Forest Journal* 56 (3) (In print).

Nsemwa, L.T.H. (1991b). Problems of banana weevil and nematodes in the Southern Highlands of Tanzania. *Fruits* 46 (5), 541-542.

Nsemwa, L.T.H. and Shao, F.M. (1990). New Record of Plant Pathogenic Fungi in Tanzania. *Tropical Pest Management* 36 (1), 74.

Samoucha, Y. and Cohen, Y. (1986). Efficacy of systemic and contact fungicide mixtures in controlling late blight. *Phytopathology* 76 (9) 855-59.

Sebasigari, K. and Stover, R.H. (1988). Banana Diseases and Pests in East Africa: Report on a Survey in November, 1987. Montipellier, France: INIBAP.

Shao, F.M. and Teri, J.M. (1985). Yield losses in *Phaseolus* beans induced by anthracnose in Tanzania. *Tropical Pest Management* 31:60-62.

TCMB. (1990). Serikali yahimiza Ugawaji Mzuri wa Madawa ya Kahawa. Kahawa News Vol. II, Nos 3 and 4. Tanzania Coffee Marketing Board.

UAC (1974-1991/92). Annual Reports. Mbeya, Tanzania: Uyole Agricultural Centre.

Walker P.T. and Hodson, M.J. (1976). Developments in maize stem-borer control in East Africa, including the use of insecticide granules. *Annals of Applied Biology* 84:111-114.