FARMERS' PERCEPTIONS OF BEAN PEST PROBLEMS IN MALAWI

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PREFACE

Beans are a near perfect food. In Malawi beans are an important crop for both food (as a major source of protein) and income (providing cash to the rural households). The crop is mostly grown by smallholder farmers in various parts of the country and yields are very low, under 500 kg/ha, making Malawi unable to feed its population. Among the constraints that affect bean production are insect pests that attack the crop both in the field and in storage. But how serious they are is not well documented. A survey was therefore conducted to gather information on insect pests that attack beans, mainly in the four impact areas of the project. This document summarises results of this survey. This information is expected to help prioritise our research efforts to develop sustainable and effective control measures and thus increase bean production at the farm level.

Financial support was provided by the Bean Improvement Project funded by the Department for International Development (DFID) of the United Kingdom. This project is executed by the Government of Malawi with technical support from CIAT (Centro Internacional de Agricultura Tropical), with the objective of helping smallholder farmers to produce more beans through use of acceptable high yielding varieties and other technologies that address their needs and constraints. The goal of the project is to increase bean production and, by making them more affordable, to increase consumption and reduce protein deficiency malnutrition in Malawi.

We hope that this initiative will contribute to the knowledge of many scientists in Africa and elsewhere who explore similar avenues in their endeavour to assist smallholder farming communities to raise their agricultural productivity.

Further information on the Malawi National Bean Programme is available from the Programme Leader, Chitedze Agricultural Research Station, P.O. Box 158, Lilongwe, Malawi.

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ACRONYMS

BIP	Bean Improvement Project
BSM	Bean stem maggot
CIAT	International Centre for Tropical Agriculture
DARTS	Department of Agricultural Research and Technical Services
DfID	Department for International Development
EPA	Extension Planning Area
MoAI	Ministry of Agriculture and Irrigation
RDP	Rural Development Project

SUMMARY

A survey was carried out to investigate farmers' perceptions of bean pest problems to complement observations made in the field; to gain an understanding of the extent of farmers' knowledge of the pests; to ascertain information on farmers' pest control methods; and to identify knowledge gaps. One hundred and eighty-two farmers were interviewed in four of the primary bean growing areas in the country: Kalira, Bembeke, South Viphya and Zidyana Extension Planning Areas (EPA's). The questionnaire addressed pest problems on both summer and winter crops where applicable and comprised pre- and post-harvest sections.

Farmers identified aphids (*Aphis fabae*), bean foliage beetle (*Ootheca* spp.) and bean stem maggot (BSM: *Ophiomyia* spp.) to be the primary pre-harvest pests. Aphids were considered to pose the most serious threat to winter crops and to be particularly severe under warm, dry conditions and on late-planted crops. Conversely, *Ootheca* attack was considered most severe on the summer crop. Severity of attack varied considerably both spatially and from year to year and was felt to be less serious on late-planted crops and under heavy rainfall conditions. BSM was considered to cause serious damage in both the summer and the winter and to attack relatively consistently both spatially and from year to year. Early-planted crops were felt to escape BSM attack to a greater degree than late-planted crops. Other pests reported by some respondents to pose a serious threat to beans were cutworms, white grubs, the striped bean weevil (*Alcidodes leucogrammus*), coreid bugs (*Anoplocnemis curvipes*, *Clavigralla* spp.) the green stink bug (*Nezara viridula*), thrips (*Megalurothrips sjostedti*), flower beetles (*Mylabris* spp.) and pod-borers (*Maruca testulalis, Heliothis armigera*).

Pests remained largely uncontrolled due to lack of knowledge of potential control measures and financial constraints. Among those farmers using control methods, chemical pesticides were the most common method used. Locally available plant materials were also used by some farmers, as well as ash, drenching with water and hand picking.

The majority of farmers reported that bean bruchids (*Acanthoscelides obtectus*, *Zabrotes subfasciatus*) consistently caused serious damage in their stores. Knowledge of post-harvest control practices was greater than of pre-harvest practices and bruchids were controlled to a large extent. Ash and chemicals were the most commonly used methods, although sunning, plant materials, sand and smoking were also used by some. There was a huge variation in the dosages used; these were usually either inadequate or excessive, and rarely as recommended.

The results of this survey highlight the urgent need for the development of cheap, effective control measures for the pre-harvest pests of beans, particularly for aphids, BSM and *Ootheca*. Furthermore, considerable effort is required to ensure that information on these measures is extended to small-holder farmers as soon as it is available. Several cheap and effective control measures for storage bruchids urgently need to be extended to farmers

INTRODUCTION

Malawi is a land-locked country surrounded by Tanzania, Zambia and Mozambique in southern Africa. It comprises 11.8 million hectares, 20% of which is occupied by Lake Malawi. Most of the country occupies a plateau at 750 to 1500m, although the northern and southern highlands reach 3000 m and in the Rift Valley floor (comprising Lake Malawi, the lakeshore zone and the Shire Valley) the altitude lies between 100 and 500m.

This topographic variation is reflected by the climate which ranges from semi-arid to sub-humid. Mean annual temperatures vary from 13°C in the Nyika Plateau to 25°C in the Shire Valley. Annual precipitation averages 1200 mm and is unimodally distributed, falling largely during the months of December to March.

With a population of approximately 11 million people, Malawi has one of the highest population densities in Africa (Ministry for Planning and Development et al., 1995). It is also one of the ten poorest countries in the world, with more than 85% of the population living in rural areas and 90% of these being smallholder farmers dependent on agriculture for their livelihood (World Bank, 1995). Most of the cultivable land is now under cultivation. Twenty percent of this land is estate land and 80% is customary land available to smallholder farmers. The limited land resources and rapidly growing population mean that land holdings are generally small, with more than 40% of smallholder households having less than 0.5 ha of land and 72% having less than 1 ha (World Bank, 1995).

Maize is the staple food for the majority of Malawians and is the most commonly grown crop, occupying approximately 70% of smallholder farmland (Scott and Maideni, 1998). Other food crops account for 27% of the land and non-food crops (e.g. burley tobacco, cotton, sugarcane, tea and coffee) for only 3%. Beans (*Phaseolus vulgaris*) are the most common food legume grown and account for approximately 10% of smallholder farm area. In Malawi, as in other countries in the region, beans are an important food and cash crop and the most important food legume (Pachico, 1989). They are a primary source of vegetable protein and an essential supplement to the maize-based diet**.**

Bean production in Malawi

Beans are produced largely during the rainy season in medium and high altitude areas of the country, where they are most commonly intercropped with maize. In some areas, particularly in the far north and south of the country where the rainy season is long enough, a second relay crop of beans is planted under maize at the grain filling stage.

Another crop is grown in the dry season under residual moisture conditions along most mid to high altitude river and stream valleys, the Shire river and areas along the lakeshore. During this season the majority of beans are grown as a monocrop, although as the bean crop matures it may be interplanted with maize in some areas.

Bean production is currently insufficient to meet the needs of the country. It is limited by a wide variety of constraints which include biotic and abiotic factors such as low soil fertility,

drought, pests and diseases, and socio-economic factors such as the lack of seed of improved varieties and poor marketing and distribution systems (Malawi Bean Improvement Project, 1997).

It is the mandate of the Bean Improvement Project (BIP) of the Department of Agricultural Research and Technical Services (DARTS) in the Ministry of Agriculture and Irrigation (MoAI) to increase bean production in the country by addressing these issues. The project is primarily addressing problems faced by the smallholder farming sector, as this is the largest and most impoverished sector. It is funded by the Department for International Development (DfID) of the British Government and the Government of Malawi with technical support from the International Centre for Tropical Agriculture (CIAT). The BIP is multi-disciplinary and includes an entomologist, whose mandate is to develop low cost technologies for control of the primary insect pests on beans in Malawi.

Insect pests as constraints to bean production

Insect pests are one of the most important constraints to bean production in Africa, causing yield losses of up to 100% (Karel and Autrique, 1989). More than 80 insect pests have been identified as being associated with beans in eastern Africa alone. Of these, approximately 20 are considered major pests of economic importance in the region.

Knowledge of the relative importance of these pests in Malawi is patchy. Hence, prior to developing an entomological research plan it was necessary to identify and prioritise the pest problems requiring attention. Throughout 1996 information was gathered via direct field observations in the main bean growing areas, and through meetings and informal discussions with farmers and entomologists in the region. In September 1996 a survey of farmers' perceptions of bean pest problems was carried out.

OBJECTIVES

The survey was carried out with the following objectives in mind:

1. To generate more information on the status of bean pests in Malawi and thus allow the determination of entomological research priorities.

2. To determine farmers' perceptions of the most serious bean pests.

3. To ascertain practices employed by farmers to control bean pests.

4. To identify knowledge gaps at which research technologies and extension messages need to be directed.

METHODS

The survey areas

Four Extension Planning Areas (EPA) were selected to represent a cross-section of the primary bean growing areas in the country: Zidyana on the lakeshore plains; South Viphya in the Viphya Hills in the north; Kalira in the Ntchisi Highlands, central region; and Bembeke in the Dedza Hills, central region.

Bembeke EPA is situated approximately 82 km southeast of Lilongwe in the Dedza Hills RDP (Rural Development Programme). It is the highest (1660 masl) and coolest of the four survey areas (Table 1). It has a mean annual rainfall of 1010 mm, which falls unimodally, largely between November and April, peaking in January. Beans are an important food and cash crop in this area, being grown by 93% of farmers (Scott *et al* 1997). Although both summer and winter crops are grown in the area, the rainy season produces the main crop.

Table 1: Agroclimatic information for the questionnaire survey sites.

RDP	Site/EPA	Elevation (masl)	Mean annual rainfall (mm)	Mean temperature (°C)	
				Dec-Apr	June-Sept
Rumphi	South Viphya	1530	1131	21.7	20.0
Ntchisi	Kalira	1560	919	21.5	19.8
Dedza Hills	Bembeke	1660	1010	21.0	19.2
Nkhotakota	Zidyana	500	1085	27.3	26.0

N.B. RDP = Rural development Project; EPA = Extension Planning Area.

Kalira EPA is in Ntchisi RDP located approximately 65 km north of Lilongwe at an altitude of 1560 m. Of the four areas, this area has the lowest mean annual rainfall (919 mm) which falls between November and April and peaks in January. Mean temperatures lie between those at Bembeke and South Viphya (Table 1). Beans are most important as a food crop here and are not grown to such a large extent as in Bembeke (86% of farmers: Scott *et al* 1997). Again, although beans are grown in both the summer and winter seasons, the main crop is grown during the rainy season.

South Viphya EPA is situated in Rumphi RDP in the northern region, approximately 330 km north of Lilongwe and at an altitude of 1530 masl. It has the highest mean annual rainfall (1131 mm) of the four areas, and the highest temperatures of the three areas where both summer and winter bean crops are grown (Table 1). Most of the farmers (97%) grow beans, mainly in the rainy season.

Zidyana EPA, located 125 km north-east of Lilongwe, in Nkhotakota RDP along the lakeshore, (500 masl) is solely a dry season bean growing area. Beans are grown on a large scale on the residual moisture remaining after the wet season rice crop has been harvested. Temperatures are high (Table 1) and, although the mean annual rainfall is good (1085 mm), this falls almost entirely outside the bean growing season.

Farmer selection

Each EPA has a drought relief list of all households in their area. Households to be interviewed were selected at random from these lists and were visited at their homes or in their fields by the enumerators. Two days were spent in each area. As the enumerators travelled by bicycle the number of households interviewed in each area was determined largely by the terrain. However, other factors such as the willingness of village chiefs and farmers to co-operate also played a role.

Interview methods

Interviews were conducted by six students from Bunda College of Agriculture. They all had previous survey experience and were trained for a week prior to the commencement of this survey. During this time the questionnaire was pre-tested and revised twice.

The questionnaire

The questionnaire addressed pest problems experienced on both summer and winter crops where applicable and comprised pre- and post-harvest sections. Wherever possible the questions were open-ended so allowing the respondents' answers to be recorded in full. Responses were coded after the completion of the survey at the data analysis stage.

In the introductory section of the questionnaire the respondent's sex and position in the household were ascertained. Respondents were then asked how many years they had been growing beans, in what seasons and whether they had had any pest problems on their beans in the previous year (winter 1995 and summer 1995/96). It was felt that the most reliable information would be gained by concentrating largely on the previous year.

In the pre-harvest section of the questionnaire farmers were asked to describe the pests attacking their beans in the last growing season, to rank them in order of importance and to classify the severity of their damage (very severe, bad, moderate, little). A colour photo board of the main bean pests was created in order to overcome problems with pest identification. The board was used to confirm the pest identities only once the farmer had described all of the pests concerning him. This was important as experience has shown that pictures can prompt farmers to name all the insects they have seen and not just those causing them problems.

The identification of BSM posed a particular problem as many farmers are not aware that the symptoms they see in their fields are caused by an insect (personal observations and Soil Pests Project, 1991). In order to try and overcome this the enumerators were asked to prompt farmers if they did not mention BSM. They described the symptoms and asked the farmers whether this was a problem they experienced.

Further information was gathered on the pests ranked first and second in importance: consistency of attack from year to year; factors affecting the severity of attack; control measures used and their effectiveness; and varietal susceptibility to attack.

Post-harvest pests

In this part of the questionnaire information was gathered on the ways in which farmers stored their beans, the problems they encountered and, where applicable, the methods of bruchid control they used. In the latter case as much detail was sought as possible in order to determine whether, when farmers use control measures they do so correctly. Differences in varietal susceptibility to bruchid attack were also addressed.

Data analysis

The data was collated and analysed using Lotus 123. Where bruchid control measures were concerned, farmers' units of measurement were converted to dosages per kilogramme of beans in order to allow comparisons to be drawn. Farmers' units were most often volumetric thus the latter involved the translation of volumes to weights.

RESULTS

The respondents

Of the 182 farmers interviewed, 36 were from Kalira, 66 from Bembeke, 54 from South Viphya and 26 from Zidyana (Table 2). Male:female ratios varied from place to place: in Kalira and Bembeke the majority of respondents were female, whereas in Zidyana most were male and in South Viphya the sex ratio was almost equal. Over all sites 73 men were interviewed, 104 women and 5 couples. 96% of the men and 20% of the women were household heads.

Table 2: The sample: numbers (and percentages) of respondents

	Kalira (n=36)	Bembeke (n=66)	South Viphya (n=54)	Zidyana (n=26)	Total (n=182)
No. of male respondents	10 (28)	15 (23)	28 (52)	20 (77)	73 (40)
Male household heads	28 (100)	14 (93)	26 (93)	20 (100)	70 (96)
Other	0	1 (7) grandson	2 (7) sons	0	3 (4)
No. of female respondents	26 (72)	48 (73)	24 (44)	6 (23)	104 (57)
Female household heads	3 (12)	10 (21)	6 (25)	2 (33)	21 (20)
Wives	22 (85)	37 (77)	18 (75)	4 (67)	81 (78)
Other	1 (4) daughter	1 (2) daughter	0	0	2 (2)
Household heads + wives	0	3 (4)	2 (4)	0	5 (3)

62% of respondents grew beans in both the wet and dry seasons, 24% only in the wet season, and 14% (at Zidyana) only in the dry season. In the wet season all respondents in Kalira, Bembeke and South Viphya grew beans whereas none did so in Zidyana, which is solely a winter bean growing area (Table 3). In the dry season 72%, 91% and 48% of respondents grew beans in Kalira, Bembeke and South Viphya respectively. Extension staff report that winter bean growing in South Viphya is limited by the lack of seed and low temperatures. However, winter temperatures here are no lower than those at Bembeke or Kalira.

Table 3: Bean cropping and storage in the four survey areas (percentage of sample)

		Kalira (n=36)	Bembeke (n=66)	South Viphya (n=54)	Zidyana (n=26)	Total (n=182)
Rainy Season	Farmers growing beans	100	100	100	0	86
	Farmers storing beans	94	92	91	0	92
Dry Season	Farmers growing beans	72	91	48	100	76
	Farmers storing beans	92	37	50	65	55

Following the wet season the majority of farmers at all sites stored beans (overall 92%). However, numbers were substantially lower following the dry season, when only 55% of all farmers stored their crop. There was also considerable variation between sites in this season.

Pre-harvest pests

All farmers reported pre-harvest pest problems. The majority of pests known to attack beans in Africa were recorded, although three pests emerged to be of primary importance: bean stem maggot (BSM), *Ootheca* spp. and aphids (Table 4).

Overall, aphids were found to be the most common pest, with 55% of farmers classifying them as very severe or bad during the dry season and 28% during the wet season. In the dry season, they posed the most serious problem at all four sites but were most severe at Zidyana and Mphompha, where 73% and 77% of farmers, respectively, perceived the attack to be very severe. Although they were also considered to be serious on the wet season crop, other pests were more so.

Aphids also showed some variation from year to year (Table 5), with 30% of farmers reporting them to be a serious pest only in some years. In dry years, under warm conditions and on late-planted crops, attacks were considered to be worse. Those farmers expressing opinions on varietal susceptibility to aphid attack generally considered all varieties to be very susceptible, although 11 of the 28 farmers mentioning Phalombe perceived it to withstand attack to some degree (Appendix 1).

Table 4: Percentage of surveyed farmers describing each pest as causing very severe or bad damage

Pest	Kalira		Bembeke		South Viphya		Zidyana	Overall	
	Wet (n=35)	Dry (n=26)	Wet (n=66)	Dry (n=60)	Wet (n=54)	Dry (n=26)	Dry (n=26)	Wet (n=155)	Dry (n=138)
Cutworm	3	12	2	32	2	8	4	2	18
White grub	14	8	12	12	7	-	23	11	9
BSM	29	23	15	5	28	12	12	23	9
Bean foliage	11	4	11	-	94	4	8	40	3
Striped bean	3	-	-	-	2	-	-	1	-
Aphids	23	54	33	38	24	77	73	28	55
Coreid bugs	-	-	3	2	-	-	-	1	1
Green stink bug	-	-	2	-	-	-	-	1	-
Thrips	-	-	2	2	-	-	-	1	1
Flower beetles	-	-	2	2	-	-	-	1	1
Pod-borers	3	4	9	-	-	-	-	4	1

Table 5: The consistency of pest attack from year to year

Pest	No. of farmers classifying pest as very severe	% of farmers classifying pests as very severe			
		every year	most years	some years	rarely
Cutworm	28	82	11	7	0
White grub	32	79	0	17	0
BSM	50	72	4	22	2
Bean foliage beetle	66	50	2	44	5
Striped bean weevil	2	100	0	0	0
Aphids	119	65	4	30	1
Coreid bugs	3	67	0	33	0
Green stink bug	1	0	100	0	0
Thrips	2	100	0	0	0
Flower beetles	2	100	0	0	0
Pod borers	8	43	0	29	29

The bean foliage beetle (*Ootheca* spp.) was also of primary concern, although only in the wet season (Table 4). A total of 40% of farmers felt that they were a serious threat to their wet

season crop. This figure is largely contributed to by the Mphompha farmers, 94% of whom considered this pest to be very severe. At Bembeke and Kalira this figure was only 11%.

Ootheca showed the most variation from year to year (Table 5), with 44% of those farmers naming it as a serious pest considering it to be so only in some years. Those farmers suggesting reasons for this generally felt that although the beetle emerged with the rains, the attack was most severe when there was little rain, as heavy rains "washed the beetles away". Farmers also noticed that later planted crops escaped attack to a greater degree than earlier planted crops. As far as varietal susceptibility to attack was concerned, Selenje was the only variety which farmers felt avoided attack to some degree (17 positive to 8 negative votes)(Appendix 1).

BSM, the third of the major pests named by farmers, was less patchy than *Ootheca* spp., with 15 to 29% of farmers classifying it as very severe or bad in the wet season and 5 to 23% in the dry season (Table 4). These figures may well be lower than they should be due to the above mentioned problems with identification. As well as having a less patchy distribution than *Ootheca*, BSM posed a more consistent threat from year to year (Table 5), with 72% of farmers saying it was serious every year. The remaining farmers felt that planting date influenced severity of attack, with later planted crops being attacked to a greater degree. Very few farmers voiced any opinion on varietal susceptibility to attack by this pest (Appendix 1).

Farmers also reported that cutworms posed a serious threat to beans, largely in the dry season at Bembeke (32%) and at Kalira (12%). However, these figures may be somewhat exaggerated as other damage is often mistakenly attributed to cutworms (personal observations). Similarly, larvae of the striped bean weevil (*Alcidodes leucogrammus*) are often misidentified as white grubs (personal observation) and may account for a significant proportion of the white grub records. The latter were reported to be most severe on the Zidyana crop (23%), followed by the wet season crop in Kalira (14%) and by both crops in Bembeke (12% each). At Bembeke, 9% of farmers also experienced severe/bad attacks by pod-borers; in other areas there were either no or very few records of this pest. There were very few records of the remaining pests.

Control measures

The survey revealed that the majority (80%) of pests classified by farmers as very severe or bad remained uncontrolled largely due to lack of knowledge of potential control measures (Table 6, Figure 1). Chemical pesticides were the most common method of control (used against 9% of severe pests)(Table 6) and were generally considered to be the most effective measure regardless of the pest. However, their use was limited by financial constraints (Figure 1). A wide variety of chemical pesticides were used (Table 7), with farmers often applying whatever chemical they could obtain regardless of whether it was recommended to combat the pest of concern. Particularly worrying is the continued use of DDT in Kalira.

Table 6: Percentage of farmers who used the various control measures and observed that altering planting date has an effect on the severity of pest attack.

Pest	No. of v. severe pest records	Control measures						Planting date
		None	Chemical	Plant materials	Ash	Water	Hand picking	
Cutworm	31	42	3	10	-	13	32	16
White grub	31	81	-	-	3	3	13	16
BSM	48	96	2	-	-	4	-	21
Bean foliage	66	88	9	2	2	-	-	53
Striped bean	2	100	-	-	-	-	-	100
Aphids	119	75	15	5	3	2	-	45
Coreid bugs	3	67	-	-	-	-	33	-
Green stink bug	1	100	-	-	-	-	-	-
Thrips	2	100	-	-	-	-	-	100
Flower beetles	2	100	-	-	-	-	-	-
Pod borers	8	75	12	-	-	-	12	100
Overall total	310	80	9	3	2	3	2	36

N.B. The percentages of farmers using the different control measures will not necessarily add up to 100% as some farmers used more than one control measure to combat one pest

Additionally, plant materials, were used by 3% of farmers (Table 6). The tubers of Dema (*Neorautanemia mitis* and *Dolichos kilimandscharicus*) were used in Kalira, and of Teta in Bembeke. The identity of Teta has yet to be ascertained but it may be the same plant as Dema (Taylor *et al*, 1997). In both cases the root is dried, ground up and mixed with water before being applied. These materials are reputedly very effective control measures for a range of pests. Additionally, in a few instances (largely against aphids and white grubs) ash was applied to the foliage. This, together with the drenching of cutworms, white grubs and aphids with water, and the hand picking of various pests, was felt to be limited in its effectiveness.

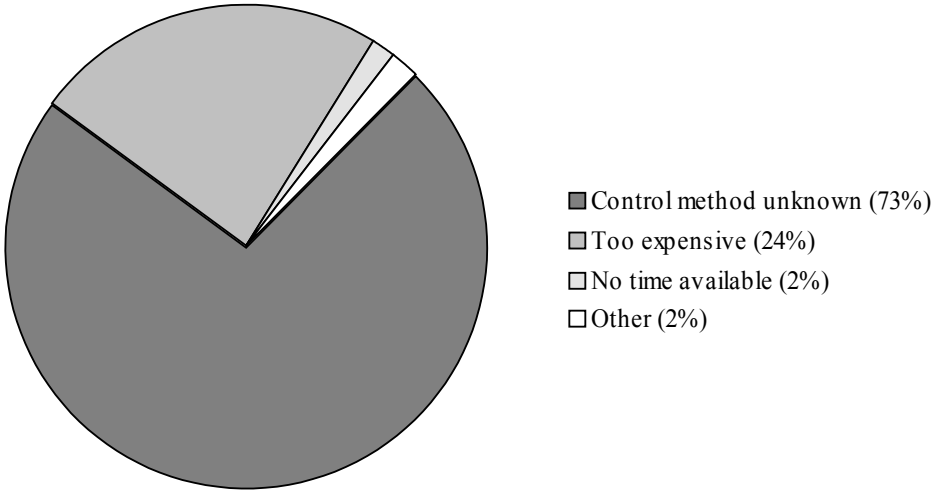

Figure 1: Reasons why control methods were not used against pre-harvest pests

Table 7: Chemical pesticides used by farmers

Pest	Kalira	Bembeke	South Viphya	Zidyana
Cutworm		Sevin (1)		
BSM			Fern (1)	
Bean foliage beetle	unknown (1)	Karate (1)	Karate (1) Fern (3)	
Aphids	Sevin (2) DDT (2) Dimethoate (4) unknown (1)	Sevin (2) Karate (1) unknown (3)		Dimethoate (4) Sevin (1)
Pod-borers	unknown (1)			

N.B. 1. Numbers in brackets refer to the number of farmers using each chemical
2. 'Unkown' indicates either that a farmer couldn't remember the name or that s/he never knew the name or that the name was unrecognisable

Aphids remained largely uncontrolled (75% of reported severe attacks) as measures were unknown (74% cases) or the cost of pesticides was prohibitive (25%). Twenty-five percent of the farmers reporting severe attacks employed control measures: chemicals (15%); plant materials (Dema)(5%); ash (3%) and water (2%). Differences were apparent between areas, with farmers at Bembeke using all four measures, those at Kalira using chemicals, plant materials and ash, those at Zidyana using chemicals, and those at South Viphya employing no control methods.

The majority (88%) of severe *Ootheca* attacks remained uncontrolled, largely because farmers knew of no control measure (65%) but also because they could not afford chemicals (26%) or time was limiting (5%). Chemicals were most commonly used as a control measure, with only one farmer at Kalira using a plant material (Dema) and one farmer at South Viphya using ash.

Considering that many farmers did not associate the symptoms of BSM attack with an insect, it was not surprising that this pest was controlled to an even lesser extent than *Ootheca* (in 96% of severe cases no control measure was taken). The majority of farmers knew of no suitable control measures (73%). Only one farmer in South Viphya used a chemical (Table 7) and two farmers in Kalira tried drenching with water.

Post-harvest pests

Storage period/methods

Bean storage was widespread among surveyed farmers, with 92% storing all or part of their wet season crop, and 55% their dry season crop. Few reasons (13) were given for not storing beans, but those that did respond cited poor harvest (54%), having sold (23%) or eaten (8%) the harvest, having replanted the seed (8%), and lack of a storage chemical (8%).

Storage period varied between areas and seasons. Farmers in Kalira, Bembeke and Mphompha stored their wet season crops for between one and eight months and on average for at least five months. Many farmers referred to the crop currently in storage, hence the storage period is artificially short and the sudden apparent removal of beans from storage in October not real (Figure 2). Beans were stored between March and November or December in Kalira and Bembeke and between April and December in South Viphya. The differences reflect the later planting of beans in the north.

The dry season crop was stored for an average of only two months in Kalira (from September), Bembeke (from October) and South Viphya (from August)(Figure 2). In Zidyana, however, dry season beans were stored for an average of 9 months and some beans were in storage during all months of the year. The radical differences in storage period reflect the time elapsing between the harvest of one crop and the planting of the next.

All except four farmers (in South Viphya) threshed their beans prior to storage. Mean time elapsing between harvest and threshing varied from four to six days in both the wet and dry seasons in Kalira, Bembeke and Zidyana, but was substantially longer in South Viphya. In this area the period averaged 40 days in the wet season and 13 days in the dry season.

The majority of farmers in all four areas stored their harvest in sacks (77 and 74% overall in summer and winter respectively) and pots (17 and 23%)(Table 8). Although farmers in Kalira and Zidyana only used these containers, those in Bembeke and South Viphya used a wider variety: cloths, tins, plates, baskets, *Nkhokwe* (traditional maize storage structures) and the bare floor. In South Viphya a larger proportion of farmers used pots than in the other areas.

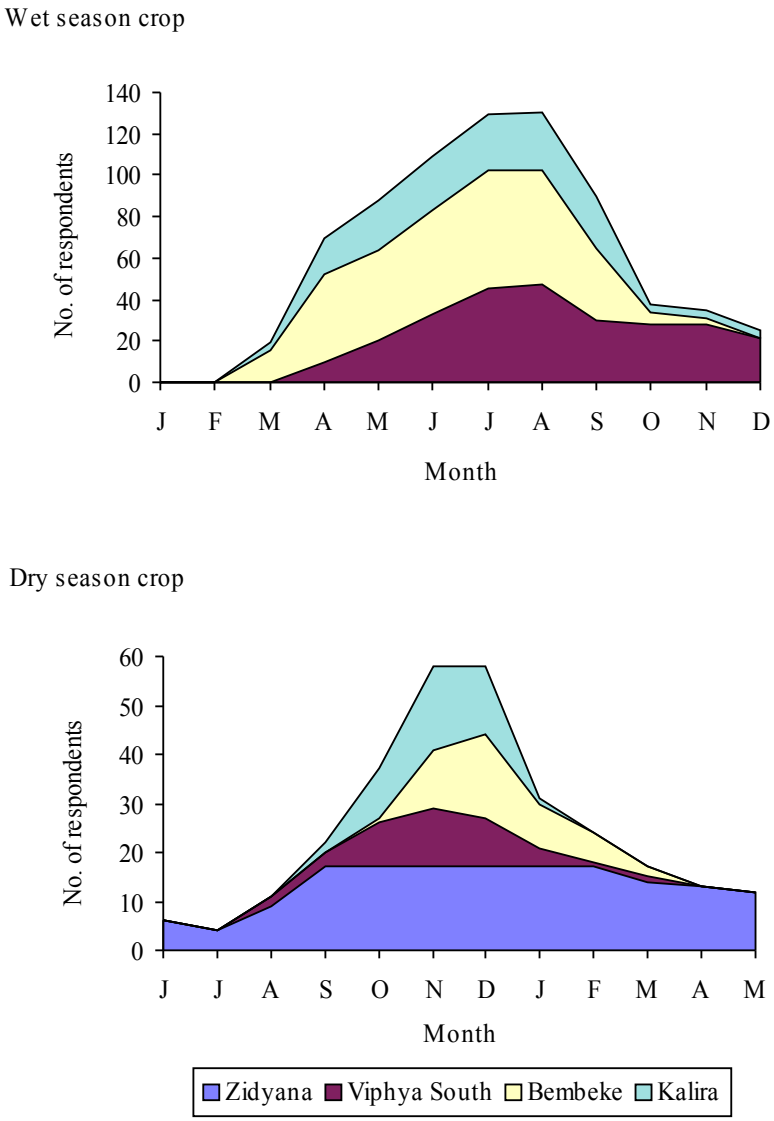

Figure 2: Months during which the wet and dry season bean crops were stored by farmers in the four areas

Table 8: Storage containers used by farmers (percentages)

	Kalira		Bembeke		South Viphya		Zidv	Total	
	Wet (n=34)	Dry (n=25)	Wet (n=61)	Dry (n=22)	Wet (n=50)	Dry (n=13)	Dry (n=17)	Wet (n=145	Dry (n=77)
Sacks	80	72	89	82	62	46	82	77	74
Pots	26	28	3	14	28	38	18	17	23
Cloths	0	0	0	0	4	15	0	10	4
Nkhok	0	0	2	5	0	0	0	1	2
Tin	0	0	0	0	2	0	0	1	0
Basket	0	0	2	0	4	0	0	2	0
Plate	0	0	2	0	0	0	0	1	0
Floor	0	0	3	0	0	0	0	1	0

Storage concerns

When asked whether they had storage concerns, 44% and 48% of respondents reported no concerns in the wet and dry seasons respectively. Further questioning revealed that a large proportion of farmers had no problems as they used control measures. If one assumes that a farmer will only use a control measure if s/he feels the problem encountered is severe enough to merit it, then the picture looks a little different. In this case it is calculated that in fact 86% and 77% of farmers had storage concerns in the wet and dry seasons respectively (Table 9).

Table 9: Farmers' storage concerns

Concerns	Kalira		Bembeke		South Viphya		Zidvana	Total	
	Wet (n=34)	Dry (n=24)	Wet (n=60)	Dry (n=22)	Wet (n=48)	Dry (n=13)	Dry (n=18)	Wet (n=142)	Dry (n=77)
None (total)	29	7	46	41	50	62	22	44	48
None	20	5	28	23	38	31	22	30	25
None	9	42	18	18	12	31	0	14	23
Respondents with concerns	91	58	82	82	88	69	100	86	77
CONCERNS									
Weevils	100	100	96	89	100	100	94	98	95
Rodents	0	0	2	0	0	0	0	1	0
Termites	0	0	2	0	0	0	0	1	0
Sprouting	0	0	2	6	0	0	6	1	3
Rotting	0	0	6	17	0	0	0	2	5

N.B. Figures represent percentages of respondents

When those farmers who had no storage concerns and used no control measures were asked why they thought they experienced no problems, those who voiced opinions (n = 17) gave short storage period (88%), cool temperatures (6%) and carefully selected seed (6%) as reasons.
Most respondents attributed their wet and dry season concerns (98% and 95% respectively) to bruchids. Rodents (0.5%), termites (0.5%), sprouting (2%) and rotting (3%) were responsible for the remaining worries largely voiced by farmers at Bembeke.

Bruchids

The remainder of the questionnaire concentrated on farmers' problems with bruchids.

As far as the proportion of the crop damaged was concerned, most farmers (76%) reported that 25% or less of the stored harvest was affected. Nine percent estimated that 50% of the harvest was affected, 9% that 75% was affected, and 6% that greater than 75% was affected.

Bruchids posed a threat consistently from year to year, with 84% of farmers reporting the attack to be bad every year. Farmers describing the attack as variable suggested several reasons: temperature, moisture, timeliness of harvest, time between harvest and storage, time between threshing and storage, and mixing with a previous harvest.

The data gathered allowed the relationship between time from harvest to threshing and weevil attack, and between storage time and weevil attack, to be investigated via a correlation analysis. Although there was no relationship between time to threshing and weevil attack, there was a significant relationship between the length of time dry season beans were in store and weevil attack ($r = 0.938$, $p = 0.031$). Interestingly, this was one factor that farmers did not suggest as influencing the extent of bruchid attack. Due to the inaccuracy of the wet season data it was not included in the analyses.

Respondents (68%) indicated that bruchids caused more damage to some bean varieties than others, and named varieties that they felt were either particularly badly attacked or which escaped attack. Many varieties had similar numbers of positive and negative votes (Appendix 1). No varieties emerged as performing markedly better than others, although several seemed to be more susceptible to attack. These were Bata in Bembeke, and Nanyati and Khaki in Kalira, Bembeke and Zidyana.

Bruchid control measures

Overall, 84% of farmers experiencing weevil problems used one or more control measures (Table 10), although at South Viphya the proportion was particularly high (98%). The measures used by farmers varied from area to area. Overall six different measures were used: chemicals, plant materials, ash, sunning, sand and smoking. Ash (used by 52% of farmers employing control measures) and chemicals (used by 50%) were the most commonly used measures overall and, together with sunning, were the only measures to be used in all four areas.

Table 10: Percentages of farmers employing measures to control bruchid attack in their stored beans

	Kalira (n=35)	Bembeke (n=66)	South Viphya (n=53)	Zidyana (n=22)	Total (n=176)
No. of farmers with bruchid problems	86	76	89	77	82
No. of farmers using one or more control measures	63	86	98	76	84
Control measures used					
Chemical	53	33	61	62	50
Plant materials	21	2	0	23	7
Ash	26	63	59	31	52
Sunning	26	23	2	38	17
Sand	0	0	2	0	1
Smoking	5	0	0	0	1

In Kalira and Zidyana chemical usage was most popular, followed by sunning, ash, and plant materials and one case of smoking in Kalira. Conversely, farmers in Bembeke preferred to use ash and, secondarily, chemicals then sunning and plant materials. In South Viphya chemicals and ash were equally popular, with only one farmer using sand and one using sunning.

Four chemicals were used to control bruchids. Actellic was the most common (used by 78% of farmers using chemicals), followed by Sevin (18%), DDT (7%) and Fern (2%). They were used (n = 60) as they were generally considered to be most effective (by 89% of farmers using them). They were also used because farmers were advised to use them (7%), because they were the only known methods of control (4%), or because chemically treated beans were still suitable for eating (2%). Farmers that knew of chemicals but did not use them (n = 56) mainly gave lack of money as a reason (77%). Very few farmers had a preferred alternative (4%) and some felt chemicals were toxic (5%) or difficult to obtain (2%). The remainder chose not to use chemicals as they were storing their harvest for a short time (5%) or had a poor harvest (9%).

Farmers mostly used ash from fuelwood burned on the cooking fire. However, bean residues and maize stalks and cobs were also specified. Ash was used (n = 63) primarily as it was cheap (73% users), but also because it was effective (15%), traditional (12%), non-toxic (8%), and the only known method (10%). Most farmers who did not use ash despite knowing of its control properties (n = 41) said it was not effective (34%) or they preferred an alternative (34%). Others said it was labour intensive and difficult to use (7%) or they had only recently heard of it (5%). The rest did not use ash due to a poor harvest (10%) or short storage time (10%).

Similarly, sunning was chosen (n = 21) largely as it was cheap (61% users) but also because it prevented rotting (11%), was traditionally used (11%), effective (6%), non-toxic (6%), other alternatives were unavailable (6%), and small quantities of beans were being stored (6%). Only three farmers (2% of those with weevil problems) knew of sunning and did not use it as they preferred alternatives (2) or it was too labour intensive (1).

The only plant material that farmers used was ground tobacco leaves (n = 8). It was cheap (71%), effective (28%) or the only known method (14%). Many more farmers knew of its use as a control measure than actually used it (18 versus 7). In some cases (22%) farmers chose to use an alternative measure instead and in others, tobacco waste was not available (17%), felt to be ineffective (17%), farmers were unsure of how to use it (11%), had only recently heard of it (6%), felt it contaminated the beans (6%), forgot (6%) or were only storing their beans for a short time (11%).

The remaining control measures were known and used by very few farmers. Only one farmer (in South Viphya) used sand as s/he felt it was effective. Two others in the area also knew of it but were unsure of its effectiveness. Similarly, only one farmer (in Kalira) smoked his beans above the kitchen fire. Another farmer in Kalira spoke of using maize flour in the past but chose to use other methods this year, and in South Viphya several farmers had used cement bags in the past but these were not available this year. Although South Viphya farmers (20%) knew that oil or paraffin could be used to control weevils, none of them used it. The most common reason was that it contaminated beans kept for food. One farmer also felt that it reduced seed germination.

Farmers using control measures were asked about the quantities used and where sunning was concerned, the frequency and duration of exposure. There was a huge amount of variation where all measures were concerned, with dosages usually being either inadequate or excessive and rarely as recommended (Appendix 2). Actellic was applied at rates varying from 0.2 g to 4.0 g Actellic per kg beans where the recommended rate is 0.44 g kg^{-1}. Ash application is recommended at a rate of at least 90g ash per kg beans and farmers' rates varied from 7 g to 582 g ash per kg beans. Similarly, sunning periods varied from one 8 hour exposure during the whole storage period to 8 hours once a week. The latter is the minimum recommended rate. Therefore information on the correct dosages is clearly lacking.

DISCUSSION

On the whole, farmer perceptions of bean pest problems agreed to a large extent with field observations. The major exception to this was BSM, the severity of which seems to have been underestimated due to farmers' (and many of the extension workers') lack of awareness that the often large scale death of bean seedlings is frequently due to BSM. Awareness of this pest needs to be increased dramatically in the country in conjunction with exposure to resistant varieties and potential cultural methods of control.

Aphids have been identified as severe bean pests throughout Africa. Malawi is no exception. Here, some farmers use ash to try and control the attack, but without great success. Pesticides, although very effective, are often not readily available and are too expensive for the small-scale farmer. The most promising management strategy may be to identify aphid-resistant bean varieties.

Despite the variability (both spatial and from year to year) in the severity of *Ootheca* attack, this pest is of major concern to farmers as it can wipe out the whole crop if it attacks at the critical (seedling) stage. It is only recently that *Ootheca* has begun to pose a serious threat to beans in Malawi and the region as a whole. Hence, much is yet to be learned of its general biology, ecological characteristics and control.

Although the survey established that farmers perceive bruchids as a major cause for concern, the collection of samples from stores is necessary to establish the actual scale of the losses due to weevils. Farmers' knowledge of control measures for bruchids was far greater than for pre-harvest pests. However, there was a great deal of variation in the knowledge from area to area and in the ways in which these measures were applied. This, together with the universal preference for chemical pesticides, suggests an urgent need for further information on all of the alternatives to be widely distributed to farmers.

As far as susceptibility of the local varieties to attack by the primary pests is concerned, farmers indicated no clear preferences. However, research in Malawi has found that local varieties do show varied degrees of susceptibility to attack by BSM. Further work is required in this area.

This survey has highlighted the urgent need for research into cheap and effective management strategies for aphids, BSM and *Ootheca* on beans in Malawi, due to the prohibitive cost of chemical pesticides to small scale farmers. By revealing that farmers in some areas make use of local plant materials (Dema, Teta and tobacco leaves) to control pests, it may be possible to incorporate indigenous methods into such management strategies following further investigation.

Furthermore, the dissemination of information, particularly with regard to the control of bruchids in farmers' stores, is something which requires attention as soon as possible.

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APPENDIX 1:Bean varietal susceptibility to attack by the major insect pests.

Local variety	S/R	Cutwor	White	BSM	Bean	Striped	Aphids	Coreid	Green	Thrips	Flower	Pod	Bruchid
Bata	S	4	1		1		12			1		2	12
	R	2					2						4
Bwenzilanga	S												1
	R												
Chikamboyi	S												1
	R												1
Chimzaza	S			1	2		1						1
	R				2		1						
Chimzimba	S				2								1
	R				6		2						4
Chitipa	S												3
	R												
Katolika	S												
	R				1								1
Kawale	S												
	R	1					1						
Kavera/Kayan	S				1		4	1					5
	R				1		3						1
Khaki	S	3	5	3	4		14						17
	R		1		1		4					1	4
Kholombe	S	1		1			2						4
	R						1						
Lilongwe	S	1	2	2									3
	R												
Mkhalatsonga	S				1		1						
	R						1						1
Mzimba	S												
	R												1
Nanyati/Sugar	S	5	2	1	29		24	1	1	1			25
	R		2		8	1	2						6
Nyauzembe	S				3		4						1
	R				2								
Phalombe/Sab	S	2	1		14		17	1				2	18
	R	2	2		3		11						18
Salima	S			2			1						5
	R						1						
Selenje	S				8	1	8						9
	R				17								4

APPENDIX 2: Methods employed by farmers to protect stored beans against bruchid attack

Table 1: Storage chemicals and doses used by farmers

Chemical	Dosage used by farmer	g chemical/kg beans
KALIRA		
Actellic	40g/50kg	0.8
Actellic	40g/90kg	0.44
Sevin	1/2 packet/5kg	4
Sevin	1pkt/1pail beans	2.58
DDT	3 tsps/pail	0.6
Sevin	2 pkts/bag	
Actellic	1pkt/pail	2.58
Actellic	5 tsps/sack	
Actellic	?	
Sevin	1 tsp/winnower	0.29
BEMBEKE		
Actellic	40g/90kg	0.44
DDT	?	
Sevin	3 teaspoons/40kg	0.23
Sevin	1 packet/50kg	
DDT, Sevin, Actellic	1 tablesp/1 flat basket	0.73
Sevin	0.5 packet/50kg	
Actellic	1 pkt/ 4 bags beans	
DDT	1 tsp/ 1 flat basket	0.29
Actellic	no real dosage	
Actellic	5 tsp/50kg	1
Actellic	3 Actellics/ 90kg=1pkt/90kg	
Actellic	0.5 bottle/ 25kgs	
Sevin	0.5 pkt/ 4 kg	
Actellic	1 pkt/ 10kg	
VIPHYA SOUTH		
Actellic	3 tsp/ pail	0.6
Actellic	use tablespoon	
Actellic	3 tbsp/ pail	1.5
Actellic	1 matchbox/ 0.5 pails	1.77
Actellic	40g/ 2 pails	1.29
Fern	bottle opened slightly to release smell	
Actellic	1 matchbox/ 50kg	0.27
Actellic	?	
Actellic	40g/ 2 pails	1.29
Actellic	40g (a packet)/ pail	2.58
Actellic	1 tbsp/ pail	0.5
Actellic	1 tsp/ pail	0.2
Actellic	3 matchboxes/ pail	2.65
Actellic	3 tbsp/ pail	1.5
Actellic	2tsp/ basin	1.27
Actellic	2 tsp/ pail	0.4

Actellic	40g (1 pkt)/ bag	
Actellic	2 tsp/ pail	0.4
Actellic	1 pkt/ tin	2.58
Actellic	1 pkt/ 2 tins	1.29
Actellic	?	
Actellic	1 pkt/ 4 tins	0.64
Actellic	?	
Actellic	?	

Appendix 2, Table 1 (continued)

Chemical	Dosage used by farmer	g chemical/kg beans
Actellic	2 tbsp/ pail	1
Actellic	?	
Actellic	?	
Actellic	50g/ pail	3.2
ZIDYANA		
Actellic	20g/pail	1.29
Actellic	250g/90kg	2.78
Actellic	40g/90kg	0.44
Actellic	40g/5 pails	0.52
Actellic, Sevin	?	
Sevin	2 pkts/2 pails	2.58
Actellic	2.5pkts/2 pails	3.23
Actellic	4 tbsp/pail	0.5

Appendix 2, Table 2: Quantities and types of ash used by farmers to control bruchids

Plant material used for ash	Quantity	g ash/kg beans	vol ash:vol beans
KALIRA			
any/mixed	?		
any/mixed	1 basin/pail beans	207.9	0.36:1
any/mixed	1 nsima plate/1 pail	43.5	0.08:1
any/mixed	1 plate/bag		
any/mixed	1 plate/pail	43.5	0.08:1
BEMBEKE			
bean	4 handfuls/50kg	8.7	0.02:1
tsamba	1 handful/10kg	10.9	0.02:1
bean haulms	1 relish plate/1 flat basket	36.3	0.07:1
firewood	1 cup/1 flat basket	30.0	0.06:1
any/mixed	1 relish plate/50kg bag	7.7	0.01:1
beans	?		
maize stalks	equal beans: ash	582.0	1:1
maize cobs	equal beans: ash	582.0	1:1
bean residues	1 ash: 3 beans	194.0	0.33:1
any/mixed	1 beans: 1 ash	582.0	1:1
bean haulms	1 plate/flat basket		
bean haulms + maize stalks	1 plate/flat basket		
bean haulms	1 plate/ flat basket		
bean haulms	1 cup/ 1 pail	20.4	0.05:1
maize stalks	1 cup/ 1 pail	20.4	0.05:1
firewood	not measured		
beans	1 pail/ 4pails	145.5	0.25:1
bean stalks	1 pail ash/3 pails beans	194.0	0.33:1
firewood	1 ndiwo plate/ 1 win basket	36.3	
firewood	1 nsima plate/ 50kg	13.5	0.02:1
maize cobs	1 nsima plate/ 90kg	7.5	0.01:1
firewood	1 pail ash/ 90kg	100.3	0.17:1
any/mixed	1 plate/ pail		
any/mixed	2 handfuls/ medium basin	44.8	0.08:1
beans	1 plate/ 50kg		
firewood	2 nsima plates/ 50kg	27.0	0.05:1
bean lvs, stems, pods	1 basin/ 50kg	64.4	0.11:1
VIPHYA SOUTH			
firewood	1 pail/ 1 pail	582.0	1:1
firewood, bean	?		

haulms etc			
firewood	1 pail/ 1 pail	582.0	1:1
firewood	1 pail		
mango and bean haulms	1 pail/ pail	582.0	1:1
any/mixed	0.5 pail/ 1 pail	291.0	0.5:1
bean haulms	1 pail/ pail	582.0	1:1
firewood	1 pail/ pail	582.0	1:1
any/mixed	?		
bean residues	?		

Appendix 2, Table 2 (continued)

Plant material used for ash	Quantity	g ash/kg beans	vol ash:vol beans
any/mixed	1 pail/ 1 pail	582.0	1:1
bean stalks	1 pail/ 1 pail	582.0	1:1
any/mixed	1 pail/ 2 pails	291.0	0.5:1
beans	1 pail/ pail	582.0	1:1
firewood	any amount		
firewood	any amount		
bean lvs, pods, stems	0.5 tin/ tin beans	291.0	0.5:1
firewood	1 tin/ tin	582.0	1:1
firewood	0.5 tin/ 1 tin	291.0	0.5:1
bean leaves, stems	0.25 tin/ tin beans	145.5	0.25:1
bean lvs, stems, pods	2-3 nsima plates/ tin	108.7	0.19:1
any/mixed	?		
any/mixed	1 pail/ pail	582.0	1:1
any/mixed	1 handful/ pail	7.0	0.01:1
any/mixed	2 handfuls/ pail	14.0	0.02:1
any/mixed	0.5 tin/ pail	291.0	0.5:1
firewood	1 pail/ 2 pails beans	291.0	0.5:1
ZIDYANA			
any/mixed	1 kg/ pail	64.5	0.1:1
any/mixed	?		
any/mixed	3 ltr/ pail	98.1	0.17:1
any/mixed	?		

Appendix 2, Table 3: Farmers' sunning regimes

Freq	Hours exposed to sun	Period
KALIRA		
1/week	10hrs	1 to 2 months
2/month	6hrs	3 months
1/week	2hrs	
1/2mths	4 to 6 hrs	2 to 3 months
1/mth		whole period
BEMBEKE		
1/week	3hrs	3 months
1/week	6-8hrs	3-4 months
once		1-2 days
1/ 3wks	6 hrs	2 months
once	6 hrs	1 day
1/week	day	1 month
1/week	2 hrs	
1/ month	3 hrs	2 months
2/ week	3 hrs	
1/ 2 weeks	6 hrs	
VIPHYA SOUTH		
once	12hrs	
ZIDYANA		
1/ mnth	day	1 month
1-2/ mnth	8hrs	
1/ 2 weeks	8hrs	
1/ 2 wks	day	10 months

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No. 25. Second Meeting of the Pan-African Working Group on Bean Entomology, Harare, 19-22 September 1993.

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No. 27. Third SADC/CIAT Bean Research Workshop, Mbabane, Swaziland, 5-7 October 1992.

No. 28. Proceedings of Third Multidisciplinary Workshop on Bean Research in Eastern Africa, Thika, Kenya, 19-22 April 1993.

No. 29. SADC Working Group Meeting of Bean Breeders, Lilongwe, Malawi, 26-29 September 1994.

No. 30. Regional Planning of the Bean Research Network in Southern Africa, Mangochi, Malawi, 6-8 March, 1991.

No. 31. Fourth SADC Regional Bean Research Workshop, Potchefstroom, South Africa, 2-4 October 1995.

No. 32. Alternative Approaches to Bean Seed Production and Distribution in Eastern and Southern Africa: Proceedings of a Working Group Meeting, Kampala, Uganda, 10–13 October 1994.

No. 33. Eastern Africa Working Group Meeting on Bean Breeding, Kampala, Uganda, 30 May 1994.

No. 34. Pan-Africa Working Group on Bacterial and Viral Diseases of Bean, Kampala, Uganda, 13-16 June 1994.

No. 35. Seminaire Regional Restreint du RESAPAC tenu a Bukavu du 25 au 27 Janvier 1995.

No. 36. VIII^{e} Seminaire Regional du RESAPAC tenu a Mukono, Uganda, du 5 au 8 Novembre 1995.

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No. 1. Talekar, N.S. 1988. Agromyzid Pests of Tropical Food Legumes: a Bibliography.

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No. 19. David, S., S. Kasozi and C. Wortmann. 1997. An Investigation of Alternative Bean Seed Marketing Channels in Uganda

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No. 11a. Trutmann, P. and Graf, W. 1993. The impact of pathogens and arthropod pests on common bean production in Rwanda. International Journal of Pest Management, 39(3): 328-333.

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