Activity 1. Make available more options for managing soil productivity and bean pests

Biology and ecology of bean foliage beetle (*Ootheca* spp.) in support of IPM

***Rationale*:** Bean farmers believed that "*Ootheca* came with the rains and disappeared with the rains". However, after realising that the insect developed in the soil within their own fields, they were eager to learn more about the biology and development in relation to their crop production systems. In addition we undertook a laboratory and screen house study to understand the details of *Ootheca* biology. The studies were initiated during 2000/01 cropping season and continued in 2001/02.

***Methods*:** Mating pairs of *Ootheca* were collected from farmers' fields and reared in the screen house. Single pairs were caged in petri dishes (9 cm diameter) filled with 15 gm of loose sterilised forest soil. They were monitored for oviposition and all eggs laid were collected, counted and incubated under ambient temperature conditions. Neonates were removed and placed in sterilised forest soil with potted bean plants. Each pot (15 cm [bottom diameter] x 20 cm [height] x 20 cm [top diameter] had 10 bean seedlings. Fifty neonates were introduced into each pot. In 2000/01 there were 168 pots. while in 2001/02, a total of 691 pots were used. Each week 6 pots were removed randomly and sampled for larvae. Head capsule widths (HCW) of all larvae collected were measured. A frequency distribution of HWC was plotted and the number of instars determined. The means and coefficient of variation were calculated for each instar and Dyar's ratio was used to separate the instars.

***Results and Discussion*:** In this second season of observation (2002), the newly emerged *Ootheca* females had a pre-oviposition period of 2 to 35 days and laid up to 865 eggs over 10 weeks **(Table 1)**. The eggs took 2 to 4 weeks to hatch at ambient temperatures between 19 and 25^{o}C. The mean soil temperature was 21.76^{o}C. Egg viability was 95.3%. There were three larval instars with the larval stage lasting over 23 weeks from April until September. Mean head capsule widths of the different instars are presented in Table 2 and the frequency distribution of larval head capsule widths in Figure 1. These laboratory and screen house studies confirm field observations on *Ootheca* development but the lab studies shed more light on the biological parameters of the larvae. The two season's observations are similar in most aspects and minor changes could be related to slight temperature fluctuations in the second season. Larval frequency distribution showed three distinct larval instars and Dyar's constant confirmed that no instars were overlooked.

Table 1. Some developmental parameters of *Ootheca* in northern Tanzania during 2002 season.

Parameter	Mean ± SEM	Range
Pre-oviposition period (days)	8.6 ± 3.9	2 – 35
Eggs laid/female	145 ± 114	1 – 185
Egg length (mm)	0.6 ± 0.02	0.58 – 0.61
Oviposition period (days)	26 ± 13.15	1 – 72
Egg batch size	51 ± 18	11 - 65
Number of batches	5.5 ± 3.03	1 - 10
Interval between batches (days)	7.68 ± 2.09	4 - 13
Incubation period (days)	15.64 ± 2.77	10 - 28
Ambient temperature (^{o}C)	22.23 ± 1.26	19 – 25
Relative humidity (%)	64.3 ± 3.9	55 - 72

Table 2. Mean head capsule widths (mm), Dyar's ration and duration of different larval instars of *Ootheca* (n=598) during 2002 season.

Instar	Head capsule width		CV (%)	Dyar's	Duration in Weeks
	Mean ± SEM	Range			
First	0.26 ± 0.023	0.19 – 0.29	9.01		3
Second	0.39 ± 0.042	0.29 – 0.46	10.82	0.699	6
Third	0.54 ± 0.059	0.46 – 0.68	11.13	0.655	14

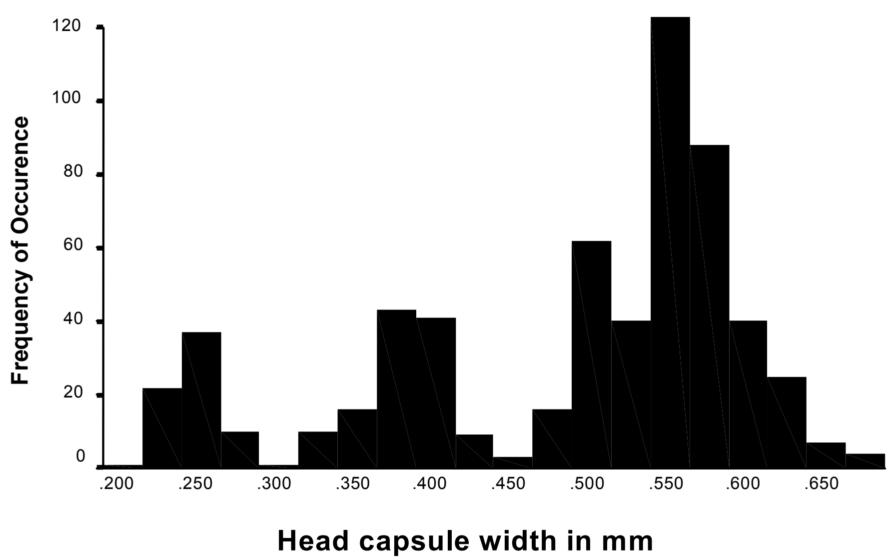

Figure 1. Frequency distribution of larval head capsule widths of *Ootheca* spp.

Contributors: K. Ampofo, H. Mziray, and E. Minja

Collaborators: E. Ulicky (DALDO, Hai District) and Farmers in Hai villages

Activity 2. Verification of farmers' indigenous knowledge on the efficacy of animal manure for bean foliage beetle management

***Rationale*:** Bean farmers in Hai district, northern Tanzania indicated that when they applied manure to beans in their homestead garden, the crop was healthy and yielded better than crops in other fields where manure was not applied. This is a well known phenomenon but we also observed a lower incidence of premature senescence and less BFB larval damage to roots. We therefore, experimented with chicken and cattle manure to gain more knowledge about these observations and the factors involved.

***Methods*:** A potted experiment was conducted in the screenhouse. It involved 3 treatments: sterilised forest soil, fully decomposed cattle and chicken manure. In the treatments involving manure, it was mixed with the soil at a 1:1 ratio. Each pot (15 cm bottom diameter, 20 cm height and 20 cm top diameter) was filled with soil or manure/soil mixture. Ten bean seeds were sown in each pot and after germination, 50 *Ootheca* neonates were introduced. There were 10 replicates for each treatment. Thirteen weeks later (end of 2nd instar), all larvae were carefully extracted from each pot and counted. The difference between introduced neonates and extracted 3rd instar larvae was determined. The data was subjected to analysis of variance (ANOVA) and means separated using Least Significant Difference test (LSD).

***Results*:** The results obtained so far indicate that there were significant (P≥0.05) differences between the 3 treatments **(Table 3)**. The number of *Ootheca* larvae that could not be accounted for, and therefore, assumed dead, was significantly (P≥0.05) higher in the mixture of soil and cattle manure compared to soil mixed with chicken manure. This suggests that there are some factors in the 2 types of manure that may have varying degrees of negative effects on larval development and survival. These results confirm the observations made by some bean farmers in Hai District. This is an important lesson learned about the validity effectiveness of farmers' indigenous knowledge in bean pest management. There is need to identify the factors/ mechanisms involved in regulating *Ootheca* larval development under the various soil conditions.

Table 3. Effect of animal manure on *Ootheca* larval development in potted bean plants at CIAT- Arusha in northern Tanzania.

Treatments	Percent Mortality
Cattle manure + soil	97.40a
Chicken manure + soil	73.60b
Soil alone	30.20c
LSD at 0.05	20.99

Column means followed by the same letter are not significantly different (P ≥0.05).

Treatments	Percent Larval Survival
Cattle manure + soil	2.60 a
Chicken manure + soil	26.40 b
Soil alone	69.80 c
LSD at 0.05	20.99

Column means followed by the same letter are not significantly different (P ≥0.05).

Contributors: K. Ampofo, H. Mziray, E. Minja, and Farmers in Hai District

Activity 3. Equip farmers for selecting among options for knowledge-intensive technologies

Relationship between bean plant yellowing symptoms ("Problem Y"), pod loss and bean foliage beetle larval damage in roots

***Rationale*:** Bean farmers in northern Tanzania sporadically experience bean plant yellowing symptoms that have been referred to as "Problem Y", and partly linked nutritional disorders. The symptoms are associated with pre-mature senescence of the crop and some farmers lose up to 90% of their crops. Farmers and researchers have not found a lasting solution to the problem. Bean foliage beetles (*Ootheca* spp.) are also among the major constraints to bean productivity in the area. Farmers and researchers have studied the pest's life cycle and evaluated strategies for management. *Ootheca* and "Problem Y" occurred on the same crop in northern Tanzania during 2002 long rainy season. The relationship between the pest and nutritional disorders on bean plants has not been investigated, but it is known that the larvae poach nodules and disturb nutrient transport within the plant.

***Methods*:** A soil sampling survey was conducted in farmers' fields in Hai District (Sanya Juu, Lawate and Kwa Sadala) and at Selian Agricultural Research Institute –SARI in Arumeru District. All farmers' fields in Hai had yellowing symptoms. Some of the farmers' fields in Arumeru and at SARI did not have the symptoms. A total of 5 fields were sampled in the 3 villages in Hai. Three field sites were sampled at SARI. Three quadrants each 1 m^2 were Randomly marked in the middle of each field irrespective of individual field sizes. All the soil at a radius of 20 cm from the bean stem and 15 cm deep was carefully scooped with the respective plant roots. The soil was sieved through a 2 mm mesh. This procedure was carried out on all plants in each quadrant. All Ootheca larvae recovered from the soil were recorded for each quadrant. The larval populations were compared among fields, sites, and villages. Ten bean plants were randomly selected from the uprooted plants in each quadrant. The total number of viable pods on individual plants was recorded. The number of pods per plant was also compared among fields, sites and villages.

***Results*:** All 3 villages sampled in Hai District had Ootheca larval infestation and bean plant yellowing symptoms **(Figure 2 & 3)**. The field sites at SARI on the other hand, were variable. Some had *Ootheca* larval infestations and yellowing symptoms, others had yellowing symptoms only and a third group were clean of pest infestation and the yellowing symptoms **(Figure 2)**. *Ootheca* larval populations were higher in fields sampled at Sanya Juu village compared to Kwa Sadala and Lawate. The high larval numbers at Sanya Juu could have accounted for the very low number of pods per plant compared to the other 2 villages. The results from Arumeru and Hai Districts show that the occurrence of both the yellowing symptoms and *Ootheca* larvae, significantly ($P \geq 0.05$) contributed to bean pod losses compared to clean fields and those that had only the yellowing symptoms **(Figure 3).**

These results appear to indicate that the occurrence of the yellowing symptoms (a nutritional disorder) and *Ootheca* infestations could have substantially contributed to bean crop yield losses in various locations of northern Tanzania during 2002 long rain cropping season. Observations in the fields indicated that bean crops planted in the first week of March were less affected by the yellowing symptoms and gave a reasonable grain yield. There is need for detailed investigations to ascertain these findings and determine other factors that could be associated with bean pod and grain yield losses in various locations of the region.

Contributors: E. Minja, H. Mziray, and K. Ampofo

Collaborators: E. Ulicky, F. Ngulu, M. Mfoi, A. Koola and Farmers at Kwa Sadala, Lawate, and Sanya Juu Villages

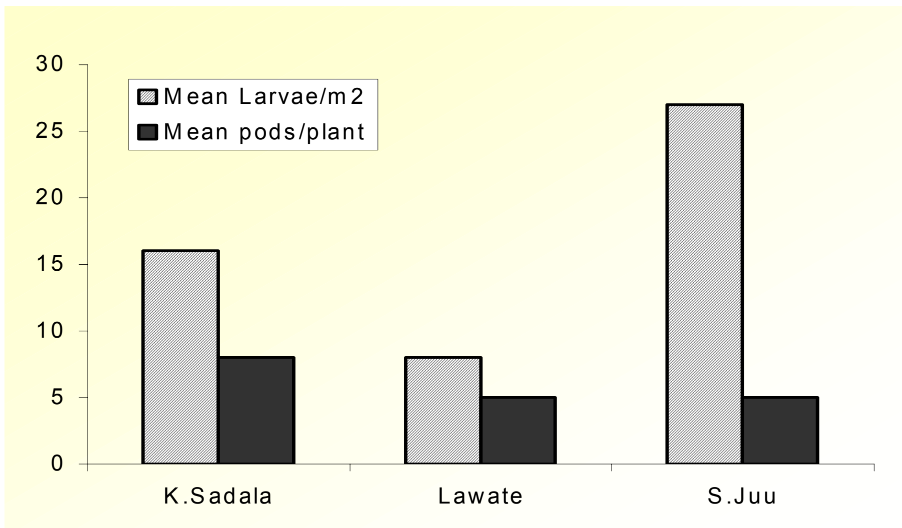

Figure 2. Contribution of *Ootheca* larvae to bean pod losses at three sites in Hai district, Kilimanjaro.

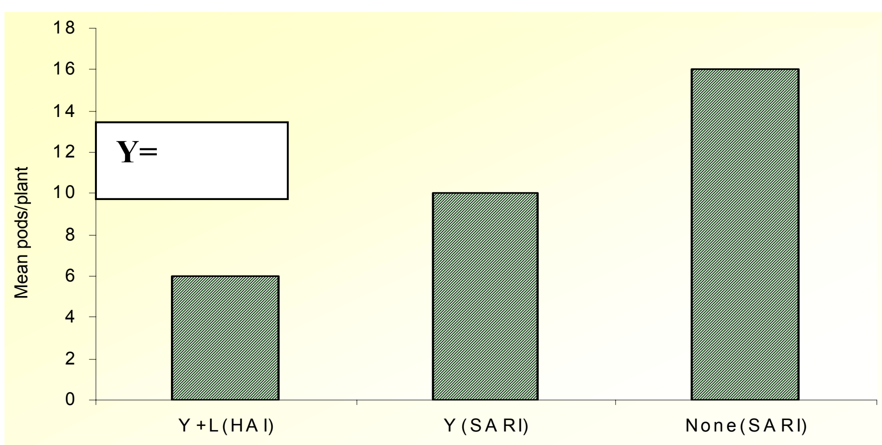

Figure 3 Contribution of *Ootheca* larvae to bean pod losses in Hai and Selian Agricultural Research Institute (SARI).

Activity 4. Scale up proven technologies through strategic alliances

Scaling up participatory IPM development and promotion

***Rationale*:** Many technologies have been developed for the management of pest problems in smallholder production systems but most have remained out of reach. Community participatory approaches, combining farmer field school and participatory approaches, are needed to increase farmer awareness of the availability of IPM technology and encourage adaptation, and to develop skills in national research and extension services.

***Methods*:** The project on, "Participatory IPM development and promotion in Eastern and Southern Africa " supported by the DFID Crop Protection Programme, aims to scale up the approach developed by CIAT in northern Tanzania to Kenya, Tanzania and Malawi. The ECABREN and SABRN Networks have also linked their IPM subprojects to this activity and are funding the extension of the project to Democratic Republic of Congo, Madagascar, Mozambique and Sudan. Collaborative links for dissemination have been developed with Zonal Communication Centre (ZCC) in the Ministry of Agriculture, Tanzania and the NGOs Farm-Africa, World Vision International -WVI (Tanzania), Adventist Development and Relief Agency –ADRA (Tanzania), Concern Universal –CU (Malawi) and Community Mobilization Against Desertification –CMAD (western Kenya).

Participating extension officers and farmer extensionists were trained in IPM methodologies including pest biology and ecology, and in the principles of participatory research. Traditional knowledge and available scientific information were discussed for their suitability in the management of major bean pest problems. The main principles were the use of community participatory approaches and the inclusion of traditional pest management strategies for evaluation and training. Farmer groups in collaboration with their research and extension personnel established learning plots at target sites in western Kenya, northern and southern Tanzania and central Malawi. The original pilot site in northern Tanzania is now fully led by extension personnel and their farmer communities, with backstopping from CIAT and the national research staff on methodology and on-station research to address basic issues raised from farmers' field observations. Farmers selected cross village and cross site visits as one of their approaches to share and exchange knowledge.

***Results*:** Observations at project sites indicated that individual farmers and groups have gained a high level of confidence through the project period and most of them could clearly explain their activities and observations with pride. Cross village farmer group visits were facilitated in western Kenya, northern and southern Tanzania. In Kenya, farmers from Kisii and Rachuonyo Districts of Nyanza Province first exchanged visits among their locations. Later in the season, farmer group representatives visited Vihiga and Hamisi Districts in Western Province in Kenya to share information on bean pest (stem maggots, pod borers, aphids) and diseases (especially root rots). Farmer and extension personnel representatives from southern and northern Tanzania jointly made an exchange visit to Lushoto. In the process, participating farmers were keen to share ideas and exchange information with other site group farmers and non-participating colleagues. All sites have strong collaboration between farmers, researchers, extension personnel and development NGOs, with regular meetings to monitor and evaluate observations in the learning plots. The national research and extension staff, ADRA, WVI and ZCC have collaborated in the translation of extension leaflets and handbooks while the ADRA and WVI have been involved in translating and meeting costs for printing initial copies of these materials.

Contributors: E. Minja, K. Ampofo, H. Mziray, J. Ogecha and D Kabungo

Collaborators: M. Pyndji, R. Chirwa, Y. Mbwana (ADRA), A. Masam (WVI), E. Ulicky (DALDO, Hai District), B. Chibambo (CU- Malawi)

Activity 5. Publications, trips, meetings, training, courses, thesis, donors and collaborating partners

Publications

Ampofo, J.K.O., Ulicky, E., Hollenweger, U., Minja, E.M., Ogecha, J., D. Kabungo and B. Chibambo. 2002. Integration of traditional and improved knowledge for bean pest management: Experience with farmers in eastern and southern Africa. Paper presented at the International **Conference** on IPM in sub-Saharan Africa, 8-12 September 2002, Kampala, Uganda. Makerere University, Kampala, Uganda.

J.K.O. Ampofo, U. Hollenweger, S.M. Massomo and E. Ulicky. Participatory IPM development and extension: the case of bean foliage beetles in Hai, northern Tanzania in: "*Participatory Technology Development for Agricultural Improvement: Challenges for institutional integration*". Proceedings of a Workshop held at IIRR, Silang Cavite, The Philippines, 17-21 September 2001.

Trips and Meetings

- Field trips were made once to field sites at Lushoto (Tanzania) and Kisii (western Kenya) in June, and several times to Hai and Arumeru Districts (Tanzania) in May, June, July, August and September.
- Trips for meetings were made twice to Kampala for annual CIAT Staff retreat in June and CIDA RBM Session in October.

Training and Courses

A series of training workshops for the IPM participating farmers and extension personnel were made at project sites in western Kenya, northern and southern Tanzania and in Malawi during February, May, June and July.

Thesis

MSc Supervision

- Mr Markus Schneider (the Swiss Federal Institute of Technology [ETH, Zurich] Switzerland) completed a diploma (MSc.) thesis on the “Biology and variations within the *Ootheca* population in northern Tanzania” under the supervision of Drs JKO Ampofo and Eli Minja.
- Dr Minja provided advisory services to 2 students registered at Jomo Kenyatta University of Agriculture and Technonology- JKUAT in Kenya. The work involves *Tephrosia vogelii* plant extracts and their efficacy on pigeonpea field and storage pests. This is a continuation of the work she was involved with while at ICRISAT.

PhD Supervision

- Ms U. Hollenweger also from the Swiss Federal Institute of Technology (ETH-Zurich) is continuing her research on “Understanding traditional pest management in sub-Saharan

Africa: an evaluation of bean pest control practices from two ethnic groups in northern Tanzania" under the supervision of Drs JKO Ampofo and Eli Minja.

- Dr Minja provided advisory services to a PhD scholar based at KARI Kisii in western Kenya and registered with the Natural Resources Institute, University of Greenwich, UK. This work is a continuation from ICRISAT, is on "On- station and on-farm testing and evaluation of sorghum genotypes for the management of major sorghum pests in western Kenya".

Donors

DFID, UK

Collaborating Partners

Farmers and national research and extension programmes in Kenya, Malawi and Tanzania
Development NGOs-
World Vision International (WVI), Adventist Development and Relief Agency (ADRA), Finance and Advice in Development Assistance in Small Enterprise Promotion (FAIDA) and Farm Africa in northern Tanzania, Concern Universal in Malawi, and Community Mobilisation Against Desertification in western Kenya.

Project Staff List

JKO Ampofo
EM Minja
HA Mziray
G Matosho