Darwin Initiative Main Project
Half Year Report
(due 31 October 2015)

Project Ref No	22-012 ref App2701
Project Title	Harnessing agricultural ecosystem biodiversity for bean production and food security.
Country(ies)	Tanzania, Malawi and UK.
Lead Organisation	Royal Botanic Gardens, Kew
Collaborator(s)	Nelson Mandela African Institution of Sci. & Technology, Arusha. Natural Resources Institute, University of Greenwich. Lilongwe University of Agriculture and Natural Resources. Charles Sturt University, Orange, Australia.
Project Leader	*Prof Philip C Stevenson*
Report date and number (e.g., HYR3)	*HYR2*
Project website/Twitter/Blog /Instagram etc	*Web site. http://agriculturalecosystems.org* *Project Twitter from @chickpeaman and @SEJArnold.*
Funder (DFID/Defra)	*DFID*

1. Outline progress over the last 6 months (April – Sept) against the agreed baseline timetable for the project (if your project has started less than 6 months ago, please report on the period since start up to end September).

Project planning workshop held in Arusha May 2016 attended by UK, Australian and Tanzanian partners to plan activities for year 2 and to mentor and train 2 associated PhDs funded through the McKnight Foundation.

Output 1. Ecosystems & plant species that are habitats for key natural enemies identified.

Plant surveys undertaken (24 locations at 3 altitudes zones). Plant diversity observed and insects' visits to plants recorded. 30 species identified through the field margin survey with a further 5 determined as other species but not yet identified. The most important or abundant plant species for pollinators included *Ageratum conyzoides*, *Commelinna benghalensis* and 3 *Bidens* spp. (including *pillosa*) (all 3 genera are noteworthy as being exotic weeds, abundant in several locations, supporting large numbers of bees, while *Bidens* and *Ageratum* have known pesticidal properties. Natural enemies of bean pests,including tachinid flies, long-legged flies, robber flies & assassin bugs were observed to be restricted to just one indigenous plant species, *Phaulopsis imbricata.* Invertebrate surveys showed the insect assemblage changed across growing season and from one location to the next.

Output 2: Key invertebrate pollinators of beans and their key habitat established.

Invertebrate biodiversity in field margins and within fields estimated. Just under 2000 insect visits to flowers were recorded across the 24 sites. The most frequently visited plant species throughout were *Ageratum conzyzoides* and *Richardia scabra*, which together were visited in around 44% of all interactions (Fig. 1). Both of these are invasive species, native to the neotropics. *A. conyzoides* is also pesticidal (Amoabeng et al., 2013). It has, however, been previously reported as a habitat/shelter for predators of agricultural pests (Liang & Huang 1994). Various species of *Bidens* contributed a further 21% of interactions. The high frequency of interactions recorded is due both to the prevalence of these plant species at sites and their attractiveness to flower visitors. Their dominance can be inferred from the quadrat/plant diversity datasets for these sites to provide a stronger indication of their relative attractiveness in light of their abundance. The putative pesticidal plants *Tagetes minuta* and *Tithonia diversifolia* received very few visits. However, *Hyptis suaveolens*, which has medicinal properties, was

Amoabeng, B. W., Gurr, G. M. Gitau, C. W., Nicol, H.I., Munyakazi, L. Stevenson, P. C. (2013). Tri-trophic insecticidal effects of African plants against cabbage pests. PLoS One. *8(10): e78651.*

visited relatively frequently by honeybees on some sites.

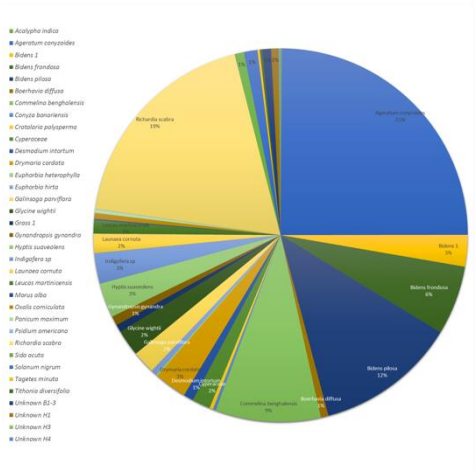

Fig. 1 Plant species recorded as visited by insects during the survey, across all sites, zones and seasons

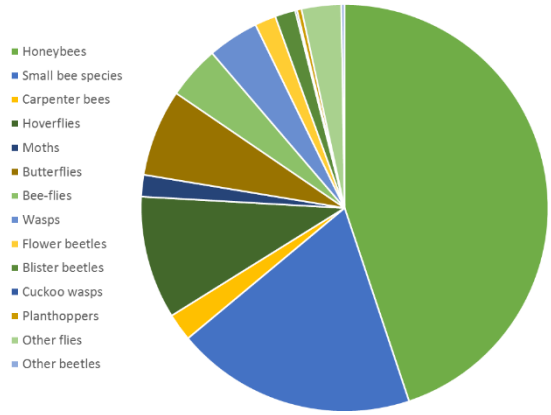

Fig. 2 Functional groups of flower visitors across all sites.

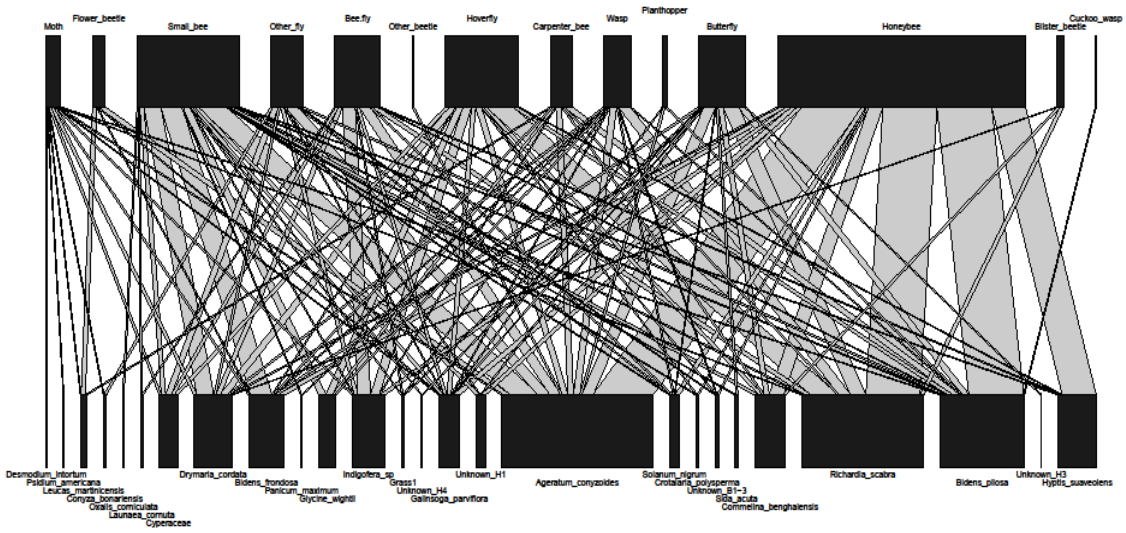

Fig 3. Illustrative pollination network (for high zone as example) showing relative frequency of visits to flowers by specific invertebrates, during bean flowering (visualised in R using the bipartite package).

Output 3: Capacity of 400 lead farmers increased by information and guidance on exploiting and maintaining agricultural biodiversity for improved crop yield.

Baseline data was reported in year 1 but data collection continued into year 2 as not all farmers were consulted in the high zone. A pilot to develop a method to collect crop and pest observations directly from farmers was run from July to October in Tanzania. This survey involved farmers from lower, mid and higher zones of Kilimanjaro providing observations about the state of their crops, application of pesticides and incidence of insects in their fields via phone calls using an interactive voice response (IVR) system. 135 farmers recruited and provided data through weekly calls over 12 weeks during the cropping period. Data collected will be combined with data from baseline surveys, including demographic information and GPS coordinates. This will be assessed for consistency, and compared, where possible, to research field observations to determine reliability of the provided data. Farmers were recruited via community meetings during which the project was explained, and a demonstration of the process was given and discussed in order to ensure the questions were clear. In addition, farmers that did not attend the community meetings but participated in the baseline survey were recruited via automated telephone call. Participants will receive TSH10,000 via mobile money transfer for answering 8 or more phone calls.

Output 4: Field margin plant species that support beneficial insects evaluated for their biological activity against pest insect species of beans and effects on beneficial insects determined.

On-station trial designed as recently published (Mkenda et al., 2015 *PLoS One*) implemented in both Malawi and Tanzania. Six field margin species (*Bidens pilosa, Lantana camara, Tephrosia vogelii, Vernonia amygdalina, Lippia javanica, Tithonia diversifolia*) tested on 5x5 plots with 4 plot replicates of each treatment randomly across the field with each species tested at 3 concentrations (10%, 1% and 0.1% w/v) plus control plots. Trials also carried out and run with support from the McKnight foundation project with farmers showed that the pesticidal plants broadly worked with some more effective than

others but the impacts on beneficial insects was significantly lower than the synthetic product. Yield of legumes was as good as the synthetic and all plant species led to better yields than the control.

Output 5: Post-graduates trained in conducting biodiversity surveys and carrying out field and laboratory based research.

The first pilot survey for invertebrates and plants was undertaken as described in last year's annual report. This year we have recruited 3 new MSc students under the supervision of Kew and NRI specialists and local partners and registered at NM-AIST. This work has established an on station experiment to determine the contribution of 5 specific key field margin plants to ecosystems service delivery for pollination and natural enemies of pests on 5 X 5m plots comprising single species field margin plantings. Students have all drafted their research proposals and defended these at viva through the university process and research data collection will be collected and analysed from October 2016. Data will focus on evaluation of sentinel plants for natural enemies and flower bagging (to exclude pollinators) experiments for pollination service. We recruited 2 PhD students who have undergone comprehensive field training in monitoring and evaluating plant and invertebrate assemblage and interactions of plants and insects making collections and progress towards an institute reference collection. The students have written up their 6 months PhD proposals and passed preliminary examination by viva. Both working on a review paper for yr 1 requirements under NM-AIST university rules. They have focussed on pollinators and natural enemies respectively and will undertake a 3 month study visit to Charles Sturt University in Australia as part of their project training. Field training was provided in February 2016 and reported on in the last annual report. We have also recruited 2 graduates to conduct complimentary transect walk surveys in Malawi.

2a. Give details of any notable problems or unexpected developments/lessons learnt that the project has encountered over the last 6 months. Explain what impact these could have on the project and whether the changes will affect the budget and timetable of project activities.

We were held up by the slow progress of recruiting PhD students at the project outset but now both are up to speed and we have been able to undertake a full season-long survey of insect plant interactions in field margins based on a complete survey of plant species and invertebrate functional groups.

2b. Have any of these issues been discussed with LTS International and if so, have changes been made to the original agreement?

Discussed with LTS:	Yes/~~No~~
Formal change request submitted:	~~Yes~~/No
Received confirmation of change acceptance	Yes/~~No~~

3a. Do you currently expect to have any significant (e.g., more than £5,000) underspend in your budget for this year?

Yes ☐ **No** ☒ Estimated underspend:

3b. If yes, then you need to consider your project budget needs carefully as it is unlikely that any requests to carry forward funds will be approved this year. Please remember that any funds agreed for this financial year are only available to the project in this financial year.

4. Are there any other issues you wish to raise relating to the project or to Darwin's management, monitoring, or financial procedures?

No

If you were asked to provide a response to this year's annual report review with your next half year report, please attach your response to this document.

Please note: Any planned modifications to your project schedule/workplan can be discussed in this report but should also be raised with LTS International through a Change Request.

Please send your **completed report by email** to Eilidh Young at Darwin-Projects@ltsi.co.uk . The report should be between 2-3 pages maximum. **Please state your project reference number in the header of your email message e.g., Subject: 20-035 Darwin Half Year Report**