Darwin Initiative Main Annual Report

To be completed with reference to the "Project Reporting Information Note":
(https://www.darwininitiative.org.uk/resources-for-projects/information-notes-learning-notes-briefing-papers-and-reviews/).

It is expected that this report will be a **maximum** of 20 pages in length, excluding annexes)

Submission Deadline: 30th April 2022

Darwin Initiative Project Information

Project reference	**29-012**
Project title	**Protecting biodiversity through biocontrol of papaya mealybug in East Africa**
Country/ies	Kenya, Uganda, South Sudan
Lead Partner	CABI
Project partner(s)	National Museums of Kenya (NMK), Kenya Plant Health Inspectorate Service (KEPHIS), Kenya Agricultural and Livestock Research Organisation (KALRO), National Agricultural Research Organization (NARO), University of Juba (UoJ)
Darwin Initiative grant value	**£501,479.00**
Start/end dates of project	1/June/2022 – 31/March/2025
Reporting period (e.g. Apr 2022 – Mar 2023) and number (e.g. Annual Report 1, 2, 3)	July 2022 – Mar 2023; Annual Report 1
Project Leader name	Ivan Rwomushana
Project website/blog/social media	N/A
Report author(s) and date	Ivan Rwomushana; 30/April/2023

1. Project summary

The project aims to address biodiversity challenges related to the invasion of papaya mealybug (PMB) in East Africa. The PMB is an invasive pest native to the Americas and has spread rapidly in East Africa between 2015- 2022, causing a 57% yield loss on papaya and resulting in household economic losses of £2,224/ha annually. Management of PMB by farmers has largely relied on the use of highly hazardous pesticides to control PMB, which negatively impacts insect biodiversity by eliminating native pollinators and natural enemies of pests. This excessive use of pesticides is reported to be the second most important driver for the worldwide decline in insect populations populations. The decline in insect biodiversity has affected smallholder farmers, especially women, who are most dependent on insect pollinators for their crop production.

The project aims to address these challenges by adopting a biological control approach to manage PMB sustainably, while protecting insect biodiversity in crops, supporting greater yield, and reducing reliance on pesticides. Classical biological control (CBC) of PMB was identified as a sustainable control measure through stakeholder activities under a Darwin-funded project. Following efficacy tests and high laboratory parasitism in quarantine, the Kenyan regulators issued a permit to release. The release of the parasitoid will reduce the heavy reliance on pesticides and protect native insect diversity, ensuring a healthier ecosystem.

The project is relevant for farmers, consumers, and the environment. The release of the parasitoid will result in higher yields, reduced economic losses, and a healthier ecosystem. Resource-limited smallholder farmers, especially women, will benefit the most from the project. They will have access to sustainable control measures, and their crop production will not be affected by the decline in insect biodiversity caused by excessive pesticide use.

The project also aims to address poverty reduction and human development challenges by reducing economic losses and ensuring food security. The decline in crop yields due to the PMB invasion has caused economic losses for smallholder farmers. The release of the parasitoid will reduce these losses, resulting in increased income and improved livelihoods. Moreover, the project will ensure food security by maintaining crop yields and reducing the dependence on costly and hazardous pesticides.

The problems were identified through scientific studies and stakeholder consultations. A CABI study predicted that if not sustainably managed, PMB would continue to rapidly spread into novel areas in East Africa. A baseline study by CABI in Kenya showed that 85% of farmers viewed the release of a biological control agent to manage PMB positively, and most farmers (94%) would support a biological control programme for PMB in their community. The lack of sustainable control measures, which led to farmers relying on pesticides, was highlighted through stakeholder activities under a Darwin-funded project. The activities of this project are undertaken in PMB-infested farms in Kenya, Uganda and South Sudan (Fig.1)

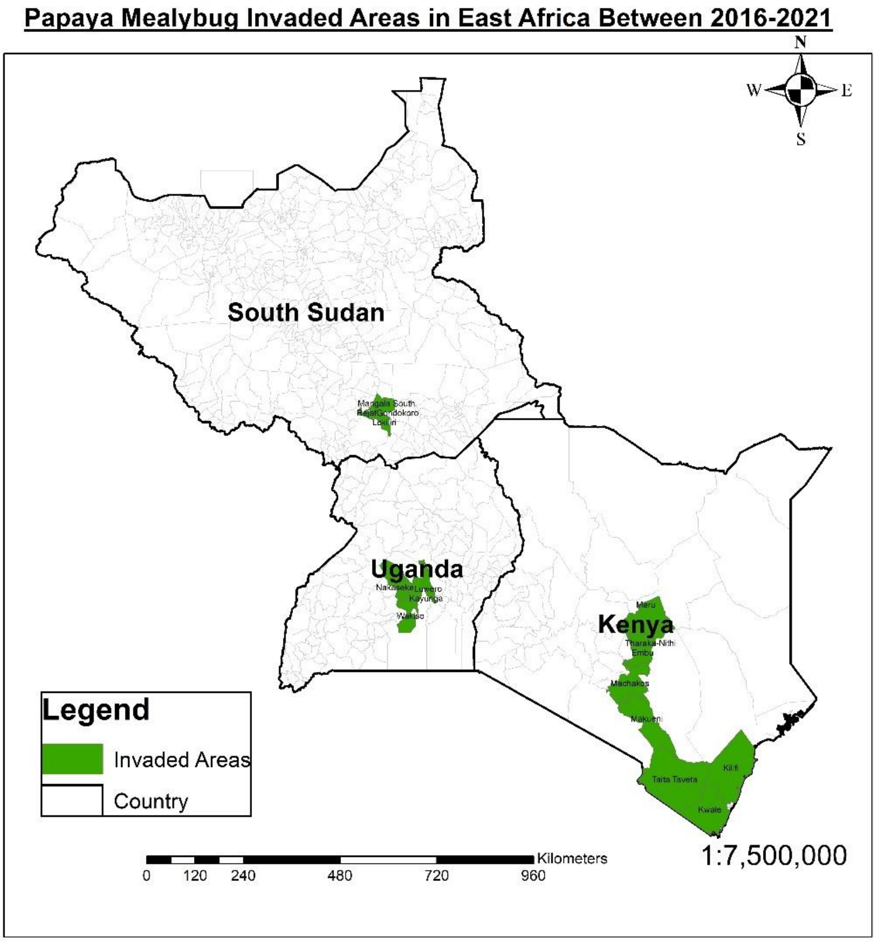

Figure 1: Papaya invaded areas in Kenya, Uganda and South Sudan

2. Project stakeholders/ partners

The forging of partnerships originated from in-country-led demand following initial consultations and the need to manage PMB. All partners were involved throughout the project in planning and decision making, as well as in producing this report. All partner institutions except for NMK and NARO signed sub-grant agreement contracts, and payments were made in 2022 after a successful inception meeting. The meeting provided a comprehensive understanding of the project and its implementation plan. Since then, strong collaboration and activity have been observed across all partner institutions. For example, CABI and NARO conducted a Participatory Rapid Rural Appraisal in Uganda to evaluate farmers' knowledge, perceptions, and practices towards the biological control of PMB for biodiversity conservation. The findings of PRRA were shared with 77 different stakeholders from various institutions in Uganda, such as farmers, researchers, regulators, government officers, extension, media, and the private sector (pesticide distributors, etc.) through a successful feedback workshop held by NARO and CABI. Training of inspectors, extension officers, and farmers on PMB biocontrol, parasitoid bioecology and conservation, and in-situ production of PMB parasitoids through Natural Enemy Field Reservoirs was carried out in Kenya through the collaborative efforts of CABI, KALRO, KEPHIS, and NMK. In total, 119 extension officers have been trained in Kenya. CABI, NMK, and NARO conducted biodiversity assessments in biological learning sites in Kenya and Uganda. NARO and CABI surveyed and identified a suspected disease in papaya in Uganda. CABI developed a training manual with support from all partners. Project activities, especially in Uganda, resulted in the development of news pieces and the publication of several blogs through the partnership with the media.

The active participation by the County Governments within the project areas and the interest by other County Governments outside the project area is a clear indication that there is a dire need to manage PMB in Kenya. Despite the strong collaboration and activity across all partner institutions, a few challenges were experienced. For instance, there were delays in the signing of the sub-contract agreement with NMK and NARO due to management changes at the organization, and very bureaucratic processes in Uganda which delayed some biodiversity activities. In South Sudan, where some of the planned activities have also been delayed due to security issues, regular engagement with UoJ is ongoing to cover the time lost due to these challenges.

3. Project progress

3.1 Progress in carrying out project activities

The project team conducted a Participatory Rapid Rural Appraisal (PRRA) in Uganda to assess the knowledge, perceptions, and practices of 333 papaya fruit growers in six sub-counties towards biological control of PMB for biodiversity conservation. The PRRA involved seventeen focus group discussions and interviews using semi-structured questions. At least 77% male and 17% female respondents were knowledgeable about PMB. The farmers mainly attributed the PMB outbreaks to low productivity and poor-quality fruits. Trees take longer to bear fruit and only last one season compared to an average of four before. Before the pest invaded, farmers obtained UGX 6-8 million/acre each season (£1,800), but currently, only obtain UGX 1 million/acre each season (£230). Pesticide sprays were the most common management practices, but they were reported as ineffective. Managing PMB with pesticides was challenging due to the waxy covering, justifying the deployment of biological control using parasitoids.

To get the buy-in from stakeholders on biological control as a means to control PMB and conserve biodiversity, a workshop was held on 29th September 2022 at NARO-Kawanda to share the PRRA results. The findings were shared with 77 different stakeholders, including farmers, researchers, regulators, government officers, extension, media, and private sector (pesticide distributors, etc.) from various institutions in Uganda. The workshop recommended biological control as a sustainable and environmentally-friendly method for the management of PMB in Uganda, which also protects the environment.

A survey and molecular identification of a suspected papaya disease was also carried out in papaya farms in Uganda. This is important in instituting early management practices to prevent spread and also protect livelihoods.

In South Sudan, the following have been achieved: Acquisition of import/export permit for the introduction of the parasitoid; pre-introduction surveys in affected to assess the incidence of PMB before introduction of *Acerophagus papayae* in South Sudan: Central, Eastern and Western Equatorial States, and to identify and designate areas for introduction *Acerophagus papayae* in South Sudan (biological learning sites).

An extension training manual for the Integrated management of PMB was also developed during the reporting period. The purpose of the manual is to guide training for papaya farmers on sustainable papaya production with a key focus on biological control, based on lessons learned worldwide. The manual also provides information about other key papaya pests that farmers are likely to encounter on their farms and how they can be managed within the IPM framework.

To prepare for the introduction and releases of the parasitoid in the different project countries, a release protocol is under development to harmonise activities and procedures for mass rearing, field release and post-release monitoring.

In terms of communication and awareness activities, in the year under review, 2 news pieces, blogs and conference participation and presentation have been done.

Output 1: **The *A. papayae* parasitoid released and naturalized in East Africa for the sustainable biological control of papaya mealybug and protection of native insect biodiversity**

Activity 1.1: Conduct ecological niche modelling to evaluate the environmental suitability for A. papayae across East Africa to identify potential release areas
Initial modelling for the parasitoid *A. papayae* has shown fair to excellent probability for establishment of the parasitoid at the coastal areas of Kenya. The model is being expanded to East Africa to predict potential establishment in Uganda and South Sudan.

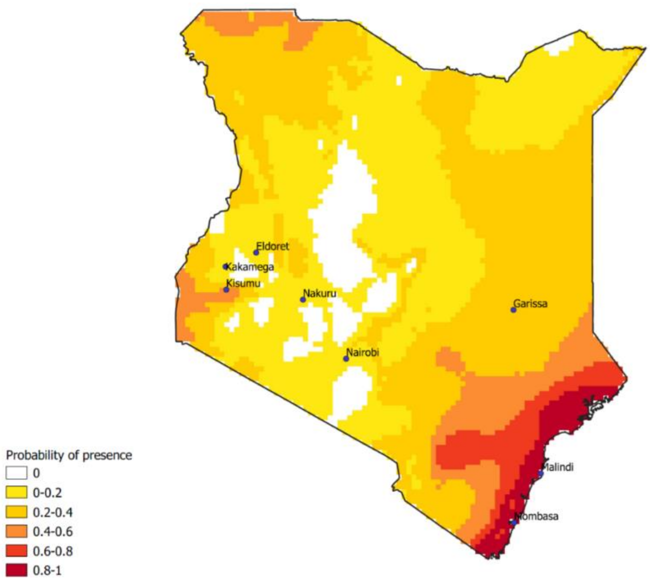

Figure 2: Ecological model for the establishment of *A. papayae* in Kenya

Activity 1.2: Undertake a baseline study at selected biological control learning sites to determine the native insect biodiversity under farmers practices.
Two biodiversity assessments have been carried out by CABI, NMK and NARO in Kenya and Uganda at selected biological learning sites. The main objectives of these studies were to assess

the native insect and plant diversity in papaya farms that will be designated as learning sites for PMB biocontrol before the introduction of the parasitoid. The studies covered 13 farms in Kenya and 6 farms in Uganda. Standard insect and plant sampling protocols were used to collect data on biodiversity in these sites. Processing of collected samples (plants and insects) is ongoing at NMK, however, to date- 86 insect species have been fully identified, with 22 identified to Genus level for Kenya. 72 species have been fully identified and 33 been identified to genus level for Uganda. In South Sudan, following pre-introduction surveys in the affected states to establish the distribution and select learning sites for the pilot release once the parasitoid is introduced, a full biodiversity assessment is scheduled for Y2Q1.

Activity 1.3: Conduct area-wide releases of A. papayae in Kenya, South Sudan and Uganda using hand releases and also deploying technology such as drones and landscape scale, Y3 Q3
Field release of the parasitoid (*A. papayae*) has been done in Kenya covering three counties heavily devasted by PMB. This activity has mainly involved the release of the biocontrol agent through mummy cards following the initial training of farmers on the maintenance of the agent. As of the writing of this report, about 684,750 parasitoids have been released with augmentation of the initially treated farms underway. The production capacity of the parasitoids has been increased from 5000 to 100,000 parasitoids per month.

In South Sudan, pre-introduction surveys have been conducted in 7 affected states to establish the distribution and select learning sites for the pilot release once the parasitoid is introduced. Plans for the introduction of the parasitoid are underway in South Sudan after the acquisition of the import permit following the presentation of the quarantine efficacy results and dossier to the competent bodies in the country. This is planned for Y2Q1 after security clearance has been obtained for the CABI team to work outside of Juba.

In Uganda, NARO presented a dossier for the introduction of the parasitoid to the papaya mealybug task force in order to get the import permit. The go-ahead from this task force will facilitate the next steps of parasitoid introduction. In addition, the technical people involved have been trained on quarantine protocols for rearing the parasitoid and are scheduled for a benchmarking (technical learning experience) activity in the CABI rearing facilities in Kenya in May 2023.

Activity 1.4: Establish A. papayae reservoirs on farmers' fields for parasitoid mass production in situ for augmentative field releases during naturalization.
Training on the in-situ parasitoid production on the establishment of the NEFRs has been conducted for farmers in three counties in Kenya. A total of 214 farmers received this training out of which 6 have set up their own version of NEFR on their farms. CABI has developed a standard prototype that will be piloted in selected biological learning sites. Similar activities will be conducted in Uganda and South Sudan once the import permit is acquired and the introduction is done respectively.

Activity 1.5: Conduct monitoring to determine post-release establishment and parasitoid efficacy as well as expansion outside the release areas,
Follow-up studies in the initially treated farms in Kenya are ongoing to evaluate the establishment and initial impact of the parasitoid on pest populations and crop production. Preliminary data shows the establishment of the parasitoid in the treated farms and has spread to about 4km from the point of release in the untreated farms. This is coupled with a reduction in pest population in these farms and reduced use of pesticides. While it is still early to fully assess the impact of the parasitoid, this data is promising. Similar activities will be carried out in Uganda and South Sudan once the parasitoid is introduced and released.

Monitoring by Kenya Plant Health Inspectorate Service (KEPHIS) as a regulator in matters related to introduction of biological control agents for classical use in Kenya has been done as required. Before release, the monitoring aimed to ascertain the following;

- Knowledge of the stakeholders like farmers, county extension staff have on the biology of the papaya mealy bug and parasitoid

- Knowledge of the stakeholders aforementioned on the application of the parasitoid and expected process leading to parasitism.
- Knowledge on the means of protecting the biological control agent to support establishment i.e. lack of spraying pesticides.
- Presence of the problem in the identified farms (presence of papaya mealy bug) before release of the biocontrol agent

Monitoring post release involved evaluation for the following;

- Adherence to the release protocol
- Presence of biocontrol agent (post-release checks) in adult and mummified stages
- Presence of other natural enemies
- Reduction in papaya mealy bug infestation
- Any undesirable occurrences in the farm including effects on non-targets.
- Interview of the farmer to evaluate their perception on the released biocontrol and its management of papaya mealybug.

Output 2: Capacity of crop inspectors, small-holder farmers, extension providers and the general public enhanced on *in situ* management of *A. papayae on* sustainable management of papaya mealybug and biodiversity conservation

Activity 2.1: Train crop inspectors in the identification of papaya mealybug and related scale insects, the A. papayae parasitoid and the biological control-biodiversity conservation nexus, Y1 Q2; Y2 Q1; Y3 Q4

Training of inspectors on PMB and other scale insect's identification, biocontrol, parasitoid bioecology and conservation, and in-situ production of PMB parasitoids through NEFRs was carried out in Kenya through the collaborative efforts of CABI, KALRO, KEPHIS, and NMK. This involved the participants being taken through the status of PMB in the country, its biology and factors aiding its spread and dispersal; other look-alikes scale insects, PMB natural enemies- ranging from predators and parasitoids; laboratory rearing of PMB and its parasitoid; PMB management and conservation of parasitoid in the field. In total, 24 inspectors officers have been trained in Kenya.

Activity 2.2: Train extension workers and community facilitators on conservation of A. papayae in the field, to support the process of naturalization, Y1 Q3; Y2 Q2, Y3 Q1, Y4 Q3

Training of extension officers, community facilitators and farmers drawn from the county governments of Kwale, Mombasa and Kilifi on PMB biocontrol, parasitoid bioecology and conservation, and in-situ production of PMB parasitoids through NEFRs was carried out in Kenya through the collaborative efforts of CABI, KALRO, KEPHIS, and NMK. In total, 134 extension officers have been trained in Kenya. This activity has not been conducted in Uganda and South Sudan due to delays in the acquisition of import permit in these countries.

An extension training manual for the Integrated management of PMB was also developed during the reporting period. The purpose is to guide training offered to papaya famers on sustainable papaya production with a key focus on biological control, based on lessons learned worldwide. The manual also provides information about other key papaya pests that farmers are likely to encounter on their farms and how they can be managed within the IPM framework.

Activity 2.3: Train farmers on in situ production of A. papayae in their farms, Y3 Q3

Farmers from the three participating counties in Kenya (Kwale, Mombasa and Kilifi) were trained on the in-situ production of *A. papayae.* This included the establishment of the NEFR approach, its monitoring and maintenance. Other topics included PMB identification, its natural enemies and look-alikes, and management. To date, 214 farmers have been trained in Kenya. Similar activities are planned for Uganda and South Sudan. To standardise this, NEFR establishment protocol has been established and is being piloted in Kenya before scaling to the other countries.

Output 3: Scientific evidence-base generated on impacts of classical biological control of A. papayae on livelihoods and native insect biodiversity

Activity 3.1: Undertake surveys to establish the effect of pesticide use on native insect biodiversity, comparing fields with and without the parasitoid, and fields with farmers pesticide practices, Y1 Q1; Y1 Q3; Y2 Q1; Y2 Q3; Y3 Q1; Y3 Q3
This activity has not begun. It is however scheduled for Y2 after the processing of the biodiversity data and designation of the biological learning sites in the three countries.

Activity 3.2: Conduct socio-economic studies to determine the impacts of the CBC approach on the population of papaya mealybug and crop infestation, Y3 Q3
This activity has not begun.

Activity 3.3: Undertake surveys to assess the impacts of A. papayae biological control on yield and incomes of smallholder households, Y3 Q3
This activity has not begun.

Activity 3.4: Generate an inventory of native insect biodiversity pre-and post-release of A. papayae to determine the positive impacts of the classical biological control programme on insect biodiversity; Y1 Q1; Y1 Q4; Y2 Q3; Y3 Q2
Two biodiversity assessment have been conducted in Uganda and Kenya (Ref to Activity 1.2). an inventory of native insect and plant diversity is being developed.

Activity 3.5: Conduct surveys to establish impacts of the classical biological control agent on non-target scale insects, Y3 Q3
This activity has not begun.

4.1: Develop an effective, gender responsive communication plan, integrating multi-channel communication approaches appropriate for reaching men and women smallholder farmers, Y1 Q3
This activity has not begun.

4.2: Produce and disseminate different information products on targeting different stakeholders on dual purpose - pest control and biodiversity conservation nexus, Y4 Q4
One blog (https://blog.plantwise.org/2022/09/14/could-biocontrol-solve-the-papaya-mealybug-problem-for-ugandan-farmers/#:~:text=Implementing%20a%20biocontrol%20programme&text=These%20will%20include%20papaya%20mealybug,in%20a%20more%20sustainable%20way.) and news piece (https://www.cabi.org/news-article/cabi-works-in-partnership-to-step-up-fight-against-pests-and-diseases-of-papaya-in-uganda/) of the PMB biocontrol have been produced during the period under review. A conference paper was also presented at NARO-MAK conference. A training manual on PMB IPM for extension officers has also been developed during this period.

3.2 Progress towards project Outputs

Output 1: **The *A. papayae* parasitoid released and naturalized in East Africa for the sustainable biological control of papaya mealybug and protection of native insect biodiversity**
Two biodiversity assessments at biological learning sites in Kenya and Uganda to evaluate native insect and plant diversity in papaya farms before introducing the parasitoid for PMB biocontrol have been conducted. An inventory of native insects and plants has been developed for Kenya and Uganda. Field releases of parasitoids was done in 207 farms in three counties in Kenya. Mass rearing capacity has been increased from 5000 to 100,000 parasitoids/month. Delays in the release of parasitoids in Uganda and South Sudan were occasioned by delays in acquiring the import permit, and security clearance for South Sudan. In Kenya, 12 NEFR have been established in six farms. An ecological niche model on the potential establishment of the parasitoid has been developed.

KEPHIS monitored the release process of the biological control agent to evaluate the positive effects (control of papaya mealy bug) and negative effects (to non-targets). During the period under evaluation, positive impact has been indicated in farms where the papaya mealybug parasitoids were released. This was evaluated through decreased number of papaya mealy bugs (infestation levels); positive feedback from the farmers where releases were done indicating a great reduction in infestation, commitment from farmers in adherence to the conservation mechanisms advised i.e. no spraying of pesticides and servicing of the NEFRs.

Output 2: Capacity of crop inspectors, small-holder farmers, extension providers and the general public enhanced on in situ management of *A. papayae* on sustainable management of papaya mealybug and biodiversity conservation
CABI, KALRO, KEPHIS, and NMK collaborated to train inspectors, extension officers and farmers in Kenya on identifying PMB and other scale insects, biocontrol, and conservation, including in-situ production of PMB parasitoids. A total of 134 extension officers, 24 inspectors and 214 farmers were trained in Kenya. An extension training manual for the Integrated management of PMB was also developed during the reporting period

Output 3: Scientific evidence-base generated on impacts of classical biological control of *A. papayae* on livelihoods and native insect biodiversity.
While a few activities under this output haven't begun, the report from the baseline biodiversity assessment provides data for comparison of any changes post-release of the parasitoid. In addition, the PRRA among 333 papaya farmers in Uganda revealed that PMB caused low productivity and poor-quality fruits, leading to substantial losses in revenue for farmers. The farmers mainly attributed the PMB outbreaks to tree infestation, which made the trees to take longer to bear fruit and only last one season instead of four. Before the pest invasion, farmers obtained UGX 6-8 million/acre each season, but now only receive UGX 1 million/acre each season due to PMB invasion.

Output 4. Information on classical biocontrol of papaya mealybug and conservation biocontrol approaches to support natural pest regulation and better management of biodiversity packaged and disseminated to increase farmer knowledge and technology adoption
One blog and news piece on PMB biocontrol have been produced during the period under review. A conference paper was also presented at NARO-MAK conference. A training manual on PMB IPM for agricultural extension service providers has also been developed during this period. A feedback workshop was conducted at NARO-Kawanda on 29th Sept 2022 to share PRRA findings with 77 stakeholders in Uganda. The workshop recommended biological control as a sustainable, environmentally-friendly method to manage PMB while conserving biodiversity.

3.3 Progress towards the project Outcome

Outcome 1: East Africans will have an increased regional capacity to manage papaya mealybug using climate-smart biocontrol thereby reducing the risk of native insect biodiversity loss and increasing incomes of farmer

Year 1 of the project saw significant progress in enhancing the capacity of inspectors, extension service providers, and farmers in Kenya on various aspects of PMB classical biocontrol. A total of 134 extension officers, 24 inspectors, and 214 farmers were trained, while engagements with similar stakeholders in Uganda also took place (PRRA and feedback meetings). Field release and in-situ production activities for the parasitoid were successfully carried out in Kenya, with efforts underway to achieve the same in Uganda; and South Sudan, where an import permit has already been acquired.

The planned areawide releases of the parasitoid are expected to significantly reduce the use of pesticides and PMB populations, leading to high crop production and increased household income. The project indicators suggest that progress towards these goals is adequate, with some possibly exceeding expectations by the project's end. The success of the project is likely to have a positive impact on biodiversity conservation and crop production, demonstrating the effectiveness of biological control as a sustainable and environmentally-friendly method for PMB management.

3.4 Monitoring of assumptions

All assumptions remain valid and none of the listed risks have impacted the outcome level. However, the release of the parasitoid was delayed due to delayed acquisition of import permits in Uganda at the output level. Political activities in Kenya and public health concerns regarding Ebola in Uganda during Year 1 did not have any effect on project activities.

More farmers are willing to participate in the program within and outside the project area. The approval to release outside the project area is made by the Kenya Standing Technical Committee on Imports and Exports based on the success of the current releases. At the moment, the effect of the parasitoids on the papaya mealybug is promising as a viable long-term control method for the pest.

3.5 Impact: achievement of positive impact on biodiversity and poverty reduction

Sustainable management of papaya mealybug achieved in East Africa through biological control thereby enhancing livelihoods and protecting native insect biodiversity threatened by pesticide use.

Upon completion of the project, the target groups will have an improved understanding of biodiversity issues linked to PMB control. Stakeholders will be equipped with sustainable skills and methods, including classical biocontrol, to manage PMB pests while promoting environmentally friendly practices. The project is on course to train relevant groups in various aspects of biocontrol including the use of parasitoids (*A. papayae*), in-situ production of natural enemies and other ecologically sound climate-smart approaches as part of the Integrated pest management for PMB and to protect East Africa's native biodiversity.

Chemical control is the main management option for most farmers including smallholder farmers. The indiscriminate use of pesticides to control PMB can result in negative consequences on biodiversity, leading to the elimination of natural enemies and the development of insecticide resistance in pests. This can increase production costs and smallholder debt, particularly for the already resource-poor farmers, and cause adverse effects on human health and the environment, including water quality. However, adopting a biological control approach like the one being proposed in this project can provide sustainable pest management, protect insect biodiversity in crops, and support higher yields, thus reducing reliance on pesticides. This approach can have significant benefits for smallholder farmers, particularly those who are struggling with poverty. Baseline data on yield and chemical control options was captured by the PRRA questionnaire.

4. Project support to the Conventions, Treaties or Agreements

This project aligns with the CBD objective to conserve biodiversity by using Classical Biological Control (CBC) as an eco-friendlier alternative to pesticides for managing invasive alien species (IAS). CBC's efficacy has been recognized by COP13 Decision XIII, and CBD guidelines and ISPM 3 will be followed for introducing *A. papayae*. The three countries are contracting parties to the IPPC, and CABI has completed pest risk assessments in Kenya, obtaining approval to release the parasitoid. An import permit has been acquired for South Sudan, and an efficacy dossier for introducing the biocontrol agent in Uganda is under consideration. This project highlights the importance of a coordinated effort among countries to protect biodiversity, emphasizing the need for safe and sustainable pest management practices.

The project has a dual aim: to achieve the Aichi Biodiversity Targets of three countries by identifying and prioritizing IAS and pathways, controlling or eradicating priority species, and implementing measures to manage pathways; and to address invasive species as a serious threat to native biodiversity in Kenya, South Sudan, and Uganda, as recognized in their National Biodiversity Strategy and Action Plans. The project has prioritised the training for inspectors, extension service providers, and farmers in Kenya (with plans underway for Uganda and South Sudan) to identify and manage PMB sustainably, which is a critical component of achieving these goals.

5. Project support to poverty reduction

This project directly benefits papaya farmers affected by PMB in Kenya, Uganda, and South Sudan by reducing pesticide use through the use of CBC against PMB. This reduction in pesticide use mitigates negative impacts on crop yields and smallholder debt, alleviating poverty. The release of the parasitoid in Kenya has already significantly reduced pesticide use, improved papaya yields, and protected native biodiversity. So far, over 207 farmers have benefited from the parasitoid releases in Kenya. Capacity building for classical and conservation biological practices for PMB among inspectors, extension workers, and farmers will enhance sustainable pest management practices in these farms, further benefiting papaya farmers.

6. Gender equality and social inclusion

In the PRRA conducted in Uganda the gender disaggregation of the participants was 264 males and 69 females. Farmers trained were 214 (96 women); inspectors 24 (18 women) and 134 extension officers (55 women)

Please quantify the proportion of women on the Project Board[1].	The chair of the Project Board is a woman
Please quantify the proportion of project partners that are led by women, or which have a senior leadership team consisting of at least 50% women[2].	Three of the project partners leads specifically NMK, KEPHIS and NARO are women, which comprises 50%

7. Monitoring and evaluation

CABI leads the overall Monitoring and Evaluation process, ensuring that project activities are on track and outputs are delivered on time. There were no major changes in the project design over the reporting period. The steering committee has met 1 time in person, and virtually whenever there is an issue to address.

8. Lessons learnt

During the reporting period, project partners from the three countries established a strong partnership to deliver key project activities through constant communication.

Delays in sub-grant agreement signatures at NMK due to management changes hindered biodiversity work, but through consultations, CABI was agreed to manage the NMK budget. A similar case related to NARO where institutional challenges still don’t permit to have a Sub-grant agreement, and therefore CABI manages the grant on behalf of the partner.

In future, there is need to sort out contracts with partners early enough to avoid activity delays.

9. Actions taken in response to previous reviews (if applicable)

Not applicable

10. Risk Management

Risk register is attached as part of this report

11. Other comments on progress not covered elsewhere

Not applicable

12. Sustainability and legacy

The project has gained recognition within the scientific community as it has received support from key national institutions responsible for agriculture and biodiversity. For example, in Kenya, 24 inspectors have been trained in PMB identification and biocontrol, most of whom are permanent staff in government institutions, which ensures the project's long-term impact. In Uganda,

[1] A Project Board has overall authority for the project, is accountable for its success or failure, and supports the senior project manager to successfully deliver the project.

[2] Partners that have formal governance role in the project, and a formal relationship with the project that may involve staff costs and/or budget management responsibilities.

stakeholders from the scientific community and private sector were informed about the project's progress in a feedback workshop that followed a PRRA. Additionally, the presentation of the project's activities at the NARO-MAK conference has enhanced its visibility. In South Sudan, the involvement of the university and stakeholders in the ministry has not only increased the project's current profile but also paved the way for future collaborations with academia. The project has made a deliberate effort to engage extension services and farmers through outreach and training activities, with the aim of continuing this goal in the coming years.

13. Darwin Initiative identity

All presentations, documents, training manuals, and teaching aids used in the project feature the Darwin Initiative logo. The project has a distinct identity that is separate from CABI's papaya mealybug work led by the PlantwisePlus program.

14. Safeguarding

Has your Safeguarding Policy been updated in the past 12 months?	No
Have any concerns been investigated in the past 12 months	No
Does your project have a Safeguarding focal point?	Yes/Lilian Kiarie, Operations Manager, Africa
Has the focal point attended any formal training in the last 12 months?	Yes/Inception Meeting for the Project
What proportion (and number) of project staff have received formal training on Safeguarding?	Past: 75 % [14] Planned: % [4]
Has there been any lessons learnt or challenges on Safeguarding in the past 12 months? Staff and partners need to recognize how to interpret safeguarding and the mechanisms for reporting	
Does the project have any developments or activities planned around Safeguarding in the coming 12 months? If so please specify. Training of partner institutions on Safeguarding is planned for 2023	

15. Project expenditure

Table 1: Project expenditure <u>during the reporting period</u> (1 April 2022 – 31 March 2023)

Project spend (indicative) since last Annual Report	2022/23 Grant (£)	2022/23 Total Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)	[redacted]			
Consultancy costs				
Overhead Costs				
Travel and subsistence				

Operating Costs	[redacted]			
Capital items (see below)	[redacted]			
Monitoring & Evaluation (M&E)	[redacted]			
Others (see below)	[redacted]			
TOTAL	**165,175.84**	**154,691.54**	**6%**	

Table 2: Project mobilising of matched funding during the reporting period (1 April 2022 – 31 March 2023)

	Matched funding secured to date	Total matched funding expected by end of project
Matched funding leveraged by the partners to deliver the project.	[redacted]	
Total additional finance mobilised by new activities building on evidence, best practices and project (£)	[redacted]	

16. OPTIONAL: Outstanding achievements or progress of your project so far

I agree for the Biodiversity Challenge Funds Secretariat to publish the content of this section

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				Yes / No

Annex 1: Report of progress and achievements against logframe for Financial Year 2022-2023

Project summary	SMART Indicators	Progress and Achievements April 2022 - March 2023	Actions required/planned for next period
Impact Sustainable management of papaya mealybug achieved in East Africa through biological control thereby enhancing livelihoods and protecting native insect biodiversity threatened by pesticide use		Increased understanding of PMB biocontrol through training of relevant groups Sustainable management of PMB through field releases of *A. papayae*	
Outcome *East Africans will have an increased regional capacity to manage papaya mealybug using climate-smart biocontrol thereby reducing the risk of native insect biodiversity loss and increasing incomes of farmers*	**Indicator 1.1**: Number of hectares (ha) established with the *A. papayae* parasitoid. **Indicator 1.2**: Number of people with improved knowledge about classical biocontrol for papaya mealybug. **Indicator 1.3:** % of expenditure reduction per ha on pesticides to control papaya mealybug on smallholder farms. **Indicator 1.4**: % of smallholder farmers with improved papaya yield by year 3.	Field release of *A. papayae* in 207 farms in Kenya 24 inspectors, 134 extension service providers and 214 farmers trained on PMB CBC in Kenya PRRA survey undertaken in Uganda (333 participants) but HH socioeconomic survey to ascertain this planned in all the countries. Not begun	Plans underway to replicate this in South Sudan and Uganda. Harmonise questionnaire or data collection tool.
Output 1. The *A. papayae parasitoid* released and naturalized in East Africa for the sustainable biological control of papaya mealybug and protection of native insect biodiversity	**Indicator** 1.1.1: Number, distribution, abundance and diversity of native insects at the selected "biological control learning sites" established by Year 1 (baseline) and Year 3 (end of project).	Two biodiversity assessments have been carried out by CABI, NMK and NARO in Kenya and Uganda at selected biological learning sites; 4 inventories for native insect (86 (full ID; 22 identified to Genus level- Kenya; 72 species fully identified; 33 identified to genus level) species) and plant (312 plant species belonging to 57 families and 205 genera- Kenya and 213 plant species belonging to 52 families and 158 genera- Uganda) diversity developed. a) Two field reports for Kenya & Uganda b) Two plants checklist for Kenya & Uganda c) Two invertebrate's checklists for Kenya & Uganda	
	Indicator 1.1.2: Number of *A. papayae* individuals produced and released in the three countries by year 3.	Field release of the parasitoid (*A. papayae*) has been done in 207 sites (~172 acres) in Kenya covering three counties heavily devasted by PMB. A total of 2739 mummy cards containing about 684,750 parasitoid mummies have been released. Import permit for introduction of the parasitoid in South Sudan acquired. Dossier on BCA introduction under consideration by the competent body in Uganda to facilitate the introduction of the parasitoid.	
	Indicator 1.1.3: Number of farmers' fields participating in mass production of farmer-managed A. papaya	1214 farmers trained on NEFR establishment and maintenance in Kenya. About 1% of the trained farmers have established their version of the NEFR. CABI has	

	parasitoid for augmentative field releases.	however developed a standard prototype to be piloted in these farms. This activity is planned for Uganda once the permit is acquired	
Activity 1.1: Conduct ecological niche modelling to evaluate the environmental suitability for *A. papayae* across East Africa to identify potential release areas, Y1 Q3		Modelling studies to evaluate the environmental suitability for *A. papayae* conducted for Kenya and being expanded to East Africa.	Publication of the model studies
Activity 1.2: Undertake a baseline study at selected biological control learning sites to determine the native insect biodiversity under farmers practices, Y1, Q3		Two baseline biodiversity assessments have been carried out in Kenya (13 farms) and Uganda (6 farms) at selected biological learning sites. 86 insect species (full ID; 22 identified to Genus level- Kenya; 72 species fully identified; 33 identified to genus level- Uganda)	Endline biodiversity assessment to be conducted post-release in Y2. Plans for South Sudan are underway.
Activity 1.3: Conduct area-wide releases of *A. papayae* in Kenya, South Sudan and Uganda using hand releases and also deploying technology such as drones and landscape scale, Y3 Q3		Field release begun in Kenya in three counties of Kilifi, Kwale and Mombasa. Import permit acquired for South Sudan.	Introduction in South Sudan and Uganda in Y2. Continued release in Y2 and Y3
Activity 1.4: Establish *A. papayae* reservoirs on farmers' fields for parasitoid mass production *in situ* for augmentative field releases during naturalization, Y1 Q3; Y2 Q2 and Y3 Q3		Establishment of NEFRs in farms in Kenya ongoing. However, 214 farmers have been trained on this.	To continue in Y2 (for Kenya) and replicate the same in South Sudan and Uganda
Activity 1.5: Conduct monitoring to determine post-release establishment and parasitoid efficacy as well as expansion outside the release areas, Y1 Q3; Y2 Q2; Y3 Q1, Y4 Q4		Not begun	To be done in Y2
Output 2. Capacity of crop inspectors, small-holder farmers, extension providers and the general public enhanced on *in situ* management of *A. papayae on* sustainable management of papaya mealybug and biodiversity conservation	**Indicator** 2.1.1: Number of crop inspectors (50% women) with improved knowledge on identification of papaya mealybug*, A. papayae* parasitoid and understand the biological control-biodiversity conservation nexus.	Training of inspectors (24) completed in Kenya.	
	Indicator 2.1.2: Number of extension workers and community facilitators (50% women) with increased capacity on mass rearing of *A. papayae* in the field, to support the process of naturalization.	134 extension officers in Kenya trained on biocontrol and infield parasitoid production.	
	Indicator 2.1.3: Number of farmers with improved skills on *in situ* production of *A. papayae* in their farms.	214 farmers trained in Kenya trained on NEFR and in situ production of *A. papayae*	

Activity 2.1. Train crop inspectors in identification of *papaya mealybug* and related scale insects, the *A. papayae* parasitoid and the biological control-biodiversity conservation nexus, Y1 Q2; Y2 Q1; Y3 Q4		Training of inspectors in Kenya completed	Plans for training inspectors in Uganda and Sudan
Activity 2.2. Train extension workers and community facilitators on conservation of *A. papayae* in the field, to support the process of naturalization, Y1 Q3; Y2 Q2, Y3 Q1, Y4 Q3		Training of extension in Kenya completed	Plans for training extension in Uganda and Sudan
Activity 2.3: Train farmers on *in situ* production of *A. papayae* in their farms, Y3 Q3		Training of farmers in Kenya ongoing	Plans for training farmers in Uganda and Sudan
Output 3. Scientific evidence-base generated on impacts of classical biological control of *A. papayae* on livelihoods and native insect biodiversity	**Indicator** 3.1.1: Evidence generated of impacts of the classical biological control agent on non-target scale insects documented by Year 2.5.	Post-release studies have been initiated in Kenya for the early treated learning farms. To be continued in Kenya and initiated in Uganda and South Sudan once parasitoid is introduced.	
	Indicator 3.1.2: Evidence generated on effect of pesticide use on native insect biodiversity, comparing abandoned and severely infested fields, infested but yielding fields with and without the parasitoid, and fields with farmers pesticide practices, and the biodiversity changes documented by Year 3.	KEPHIS currently generating evidence of pesticide use in different cropping systems	
	Indicator 3.1.3: Evidence generated on impacts of the classical biological control approach on the population of the papaya mealybug and crop infestation documented by Year 3.	KEPHIS currently generating evidence of impacts of the classical biological control approach on the population of the papaya mealybug and crop infestation.	
	Indicator 3.1.4: Evidence generated impacts of *A. papayae* biological control on yield and incomes of smallholder households (30% women owned) documented by Year 3.	Not began. To be initiated in Y2. Baseline data from the PRRA in Uganda to be compared with an endline study post release. Household surveys (Baseline and endline) to be conducted.	
	Indicator 3.1.5: Evidence generated on the native insect biodiversity post-release of *A. papayae* documented to determine the positive impacts of the classical biological control programme by Year 2.5.	Not begun. Baseline biodiversity completed in Kenya and Uganda. Inventories for native insect in biological learning sites in Kenya and completed.	

Activity 3.1: Undertake surveys to establish the effect of pesticide use on native insect biodiversity, comparing fields with and without the parasitoid, and fields with farmers’ pesticide practices, Y1 Q1; Y1 Q3; Y2 Q1; Y2 Q3; Y3 Q1; Y3 Q3		Initiated in Kenya	Plans for carrying out this in Uganda and Sudan in Y2
Activity 3.2: Conduct socio-economic studies to determine the impacts of the CBC approach on the population of papaya mealybug and crop infestation, Y3 Q3		PRRA conducted in Uganda	Socio-economic surveys planned for Y2 in Kenya and South Sudan.
Activity 3.3: Undertake surveys to assess the impacts of *A. papaya*e biological control on yield and incomes of smallholder households, Y3 Q3		Not begun	
Activity 3.4: Generate an inventory of native insect biodiversity pre-and post-release of *A. papayae* to determine the positive impacts of the classical biological control programme on insect biodiversity; Y1 Q1; Y1 Q4; Y2 Q3; Y3 Q2		4 inventories for native insects and plant diversity developed	
Activity 3.5: Conduct surveys to establish impacts of the classical biological control agent on non-target scale insects, Y3 Q3		Not began	
Output 4. Information on classical biocontrol of papaya mealybug and conservation biocontrol approaches to support natural pest regulation and better management of biodiversity packaged and disseminated to increase farmer knowledge and technology adoption	**Indicator** 4.1.1: Number of smallholder farmers that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5.	Not begun	
	Indicator 4.1.2: Number of extension officers that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5.	Not begun	
	Indicator 4.1.3: Number of stakeholders that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5.	Not begun	
	Indicator 4.1.4: Number of information products (media articles, policy brief, impact stories, fact sheets, journal articles) targeting different stakeholders developed and disseminated by Year 1.	A blog and a news article on PMB biocontrol have been published. A conference paper was also presented at the NARO-MAK conference	

Annex 2: Project's full current logframe as presented in the application form (unless changes have been agreed)

Monitoring work flow	Measurable Indicators	Means of verification (MoV)	Important Assumptions
IMPACT: Sustainable management of papaya mealybug achieved in East Africa through biological control thereby enhancing livelihoods and protecting native insect biodiversity threatened by pesticide use	**Indicator** 1.1a: % of hectares of land with increased distribution, abundance and diversity of native insect enemies. Baseline 2019=0 Milestone 2023=5% Target 2025=10% **Indicator** 1.1b: % reduction in papaya yield losses associated with papaya mealybug. Baseline 2019=57% Milestone 2023=30% Target value 2025= 20% **Indicator** 1.1c: % of households with improved income from papaya production.	End of project evaluation report Biodiversity assessment report in Year 3	The local environmental factors for Uganda, Southern Sudan are similar to Mombasa, Kenya (no drastic change to curtail spread of the parasitoids) Weather patterns are conducive for papaya crop production Risk: Covid-19 restrictions are lifted to enable people to move and gather.
Outcome 1: East Africans will have an increased regional capacity to manage papaya mealybug using climate-smart biocontrol thereby reducing the risk of native insect biodiversity loss and increasing incomes of farmers	**Indicator 1.1**: Number of hectares (ha) established with the *A. papayae* parasitoid. Baseline 2022 =0 Milestone 2023=45000 ha Target: 75000 ha **Indicator 1.2**: Number of people with improved knowledge about classical biocontrol for papaya mealybug. Baseline value=0 Target value=15000 (40% women) Milestone 2023 =1000 **Indicator 1.3:** % of expenditure reduction per ha on pesticides to control papaya mealybug on smallholder farms. Baseline 2019=51% (£204) Milestone =30% (£143) Target =50% (£102) **Indicator 1.4**: % of smallholder farmers with improved papaya yield by year 3.	Mid-term and end of project assessment of papaya farmers to establish presence, or absence of the parasitoid Impact assessment report on the household and community benefits of the project. Farmer reports and Country records on frequency of pesticide use and associated expenditure.	Farmers are willing to take up the use of classical biological control for papaya mealybug and reduce pesticide use.
Outputs 1: The *A. papayae parasitoid* released and naturalized in East Africa for the sustainable biological control of	**Indicator** 1.1.1: Number, distribution, abundance and diversity of native insects at the selected "biological control learning sites" established by Year 1 (baseline) and Year 3 (end of project).	Museum collection and baseline report of native insects at the "biological control learning sites"	Multiple open data sources are available and accessible on parasitoid distribution for ecological modelling.

Monitoring work flow	Measurable Indicators	Means of verification (MoV)	Important Assumptions
papaya mealybug and protection of native insect biodiversity	**Indicator** 1.1.2: Number of *A. papayae* individuals produced and released in the three countries by year 3. Baseline=5000 Milestone=120000 Target=300000 **Indicator** 1.1.3: Number of farmers' fields participating in mass production of farmer-managed *A. papaya* parasitoid for augmentative field releases. Baseline=0 Milestone=10 Target =100 (50 women)	Records of the number of *A. papayae* reservoirs set up on farmers' for *A. papayae* parasitoid mass production in Kenya, South Sudan and Uganda Post-release assessments report with a list and country maps of georeferenced farms where *A. papaya*e is released and established	Permits for release of the parasitoid are obtained in a timely manner from the government agencies in charge Farmers and local governments allow the mapping of their farms for monitoring purposes
Output 2: Capacity of crop inspectors, small-holder farmers, extension providers and the general public enhanced on *in situ* management of *A. papayae on* sustainable management of papaya mealybug and biodiversity conservation	**Indicator** 2.1.1: Number of crop inspectors (50% women) with improved knowledge on identification of papaya mealybug, *A. papayae* parasitoid and understand the biological control-biodiversity conservation nexus. Baseline =0 Milestone 2024 =10 Target=30 **Indicator** 2.1.2: Number of extension workers and community facilitators (50% women) with increased capacity on mass rearing of *A. papayae* in the field, to support the process of naturalization. Baseline=0 Milestone 2024=100 Target=300 **Indicator** 2.1.3: Number of farmers with improved skills on *in situ* production of *A. papayae* in their farms. Baseline=0 Milestone=30 Target=150 (50 women)	Monitoring reports on capacity, knowledge, skills of crop inspectors, extension workers and community facilitators on papaya mealybug management and biodiversity conservation Reports on parasitoid mass rearing, and training attendance lists Report of farmers trained on *in situ* production of *A. papayae* and attendance lists	Equipment for setting up field reservoirs at farmers' fields is readily available. Risk: Covid-19 persists to restrict gatherings necessary to conduct practical in-person farmer trainings.

Monitoring work flow	Measurable Indicators	Means of verification (MoV)	Important Assumptions
Output 3: Scientific evidence-base generated on impacts of classical biological control of *A. papayae* on livelihoods and native insect biodiversity	**Indicator** 3.1.1: Evidence generated of impacts of the classical biological control agent on non-target scale insects documented by Year 2.5. **Indicator** 3.1.2: Evidence generated on effect of pesticide use on native insect biodiversity, comparing abandoned and severely infested fields, infested but yielding fields with and without the parasitoid, and fields with farmers pesticide practices, and the biodiversity changes documented by Year 3. **Indicator** 3.1.3: Evidence generated on impacts of the classical biological control approach on the population of the papaya mealybug and crop infestation documented by Year 3. **Indicator** 3.1.4: Evidence generated impacts of *A. papayae* biological control on yield and incomes of smallholder households (30% women owned) documented by Year 3. **Indicator** 3.1.5: Evidence generated on the native insect biodiversity post-release of *A. papayae* documented to determine the positive impacts of the classical biological control programme by Year 2.5.	Scientific publication on the impacts of the parasitoid on non-target scale insects and other native beneficial insects Scientific publication on the post-release impact of the classical biological control programme on PMB infestation Scientific publication on the socio-economic impact of the parasitoid release on yield, pesticide use and income (both papaya and other insect pollinated crops Baseline and final report and maps showing distribution and abundance of native insect species in papaya agro-ecologies Museum collections of native inspect species from the release sites in space and time	Smallholder farmers and extension workers are willing to participate in the surveys
Output 4. Information on classical biocontrol of papaya mealybug and conservation biocontrol approaches to support natural pest regulation and better management of biodiversity packaged and disseminated to increase farmer knowledge and technology adoption	**Indicator** 4.1.1: Number of smallholder farmers that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5. Baseline=0 Milestone=30 Target=100 **Indicator** 4.1.2: Number of extension officers that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5.	Manual documenting the best practices of pest control and biodiversity conservation Blogs, social media articles, Publications, radio programmes, fact sheets, photo sheets, pamphlets, brochures; project	National stakeholders are willing to collaborate in providing information. Political and public health concerns such as Covid-19 are suitable for holding mass awareness activities.

Monitoring work flow	Measurable Indicators	Means of verification (MoV)	Important Assumptions
	Baseline=0 Milestone=10 Target=30 **Indicator** 4.1.3: Number of stakeholders that are aware of various gender-responsive communication on classical biocontrol of papaya mealybug by Year 2.5. Baseline=0 Milestone=50 Target=100 **Indicator** 4.1.4: Number of information products (media articles, policy brief, impact stories, fact sheets, journal articles) targeting different stakeholders developed and disseminated by Year 1. Baseline=0 Milestone=3 Target =10	progress and final reports; feedback from stakeholders in the final report Mid-term M&E report on pesticide use, Training reports and attendance sheets for workshops Insect pass mass rearing records of parasitoids produced/week	

Activities

1.1: Conduct ecological niche modelling to evaluate the environmental suitability for *A. papayae* across East Africa to identify potential release areas, Y1 Q3

1.2: Undertake a baseline study at selected biological control learning sites to determine the native insect biodiversity under farmers practices, Y1, Q3

1.3: Conduct area-wide releases of *A. papayae* in Kenya, South Sudan and Uganda using hand releases and also deploying technology such as drones and landscape scale, Y3 Q3

1.4: Establish *A. papayae* reservoirs on farmers' fields for parasitoid mass production *in situ* for augmentative field releases during naturalization, Y1 Q3; Y2 Q2 and Y3 Q3

1.5: Conduct monitoring to determine post-release establishment and parasitoid efficacy as well as expansion outside the release areas, Y1 Q3; Y2 Q2; Y3 Q1, Y4 Q4

2.1: Train crop inspectors in identification of *papaya mealybug* and related scale insects, the *A. papayae* parasitoid and the biological control-biodiversity conservation nexus, Y1 Q2; Y2 Q1; Y3 Q4

2.2: Train extension workers and community facilitators on conservation of *A. papayae* in the field, to support the process of naturalization, Y1 Q3; Y2 Q2, Y3 Q1, Y4 Q3

2.3: Train farmers on *in situ* production of *A. papayae* in their farms, Y3 Q3

3.1: Undertake surveys to establish the effect of pesticide use on native insect biodiversity, comparing fields with and without the parasitoid, and fields with farmers pesticide practices, Y1 Q1; Y1 Q3; Y2 Q1; Y2 Q3; Y3 Q1; Y3 Q3

Monitoring work flow	Measurable Indicators	Means of verification (MoV)	Important Assumptions
3.2: Conduct socio-economic studies to determine the impacts of the CBC approach on the population of papaya mealybug and crop infestation, Y3 Q3 3.3: Undertake surveys to assess the impacts of *A. papaya*e biological control on yield and incomes of smallholder households, Y3 Q3 3.4: Generate an inventory of native insect biodiversity pre-and post-release of *A. papayae* to determine the positive impacts of the classical biological control programme on insect biodiversity; Y1 Q1; Y1 Q4; Y2 Q3; Y3 Q2 3.5: Conduct surveys to establish impacts of the classical biological control agent on non-target scale insects, Y3 Q3 4.1: Develop an effective, gender responsive communication plan, integrating multi-channel communication approaches appropriate for reaching men and women smallholder farmers, Y1 Q3 4.2: Produce and disseminate different information products on targeting different stakeholders on dual purpose - pest control and biodiversity conservation nexus, Y4 Q4			

Annex 3: Standard Indicators

Table 1 Project Standard Indicators

DI Indicator number	Name of indicator using original wording	Name of Indicator after adjusting wording to align with DI Standard Indicators	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
DI-D01	Number of hectares (ha) established with the *A. papayae parasitoid*.	Number of hectares (ha) established with the A. papayae parasitoid.	Acres	Farms	172 acres				75000ha
DI-D01	Number of *A. papayae* individuals produced and released in the three countries by year 3.	Production capacity of A. papayae increased and released in the three countries	Number	None	684,750 mummies			684,750	300,000
	% of expenditure reduction per ha on pesticides to control papaya mealybug on smallholder farms.	Proportion of pesticide expenditure cost for PMB control	Proportion	Households	0			0	Reduced by 50%
	% of smallholder farmers with improved papaya yield by year 3	Proportion of smallholder farmers with improved papaya yield.	Proportion	Households	TBD			0	15,000
DI-A01	Indicator 2.1.1: At least 10 crop inspectors (50% women) trained in identification of papaya mealybug, *A. papayae* parasitoid and have an understanding of the biological control-biodiversity conservation nexus by Year 1	Number of crop inspectors trained on identification of papaya mealybug, A. papayae parasitoid and understand the biological control-biodiversity conservation nexus	People	Men Women	24			24	60
	Indicator 2.1.2: At least 100 extension workers and community facilitators (50% women) trained on mass rearing of A. papayae in the field, to support the process of naturalization by Year 1.5	Number of extension workers and community facilitators (50% women) trained on mass rearing of *A. papayae* in the field, to support the process of naturalization.	People	Men Women	134			134	300

	Indicator 2.1.3: 150 (50 women) farmers trained on in situ production of A. papayae in their farms by Year 2	Number of farmers trained on in situ production of *A. papayae* in their farms.	People	Men Women	214			214	150
	Number of *A. papayae* individuals produced and released in the three countries by year 3.	Production capacity of A. papayae increased and released in the three countries	Number	None	684,750 mummies			684,75 0	300,000
DI-C19	At least 10 (media articles, policy brief, impact stories, fact sheets, journal articles) information products targeting different stakeholders developed and disseminated by end of the project by Year 1	Number of information products targeting different stakeholders developed and disseminated	Number	None	2			2	10

Table 2 Publications

Title	**Type** (e.g. journals, manual, CDs)	**Detail** (authors, year)	**Gender of Lead Author**	**Nationality of Lead Author**	**Publishers** (name, city)	**Available from** (e.g. weblink or publisher if not available online)
Farmers' knowledge and impact associated with the invasive papaya mealybug in Uganda"	Conference paper	Nankinga et al.2022	F	Uganda	Kampala	Book of Abstract: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://naromakconference.org/wp-content/uploads/2023/03/NARO-MAK-Program.pdf

Annex 4: Onwards – supplementary material (optional but encouraged as evidence of project achievement)

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	Yes
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	Yes
Is your report more than 10MB? If so, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	No
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Yes
Do you have hard copies of material you need to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number. However, we would expect that most material will now be electronic.	No
If you are submitting photos for publicity purposes, do these meet the outlined requirements (see section 16)?	Yes
Have you involved your partners in preparation of the report and named the main contributors	Yes
Have you completed the Project Expenditure table fully?	Yes
Do not include claim forms or other communications with this report.	