Department for Environment Food & Rural Affairs

DARWIN INITIATIVE

Funded by UK Government

Darwin Initiative: Final Report

*To be completed with reference to the "Writing a Darwin Report" guidance: (http://www.darwininitiative.org.uk/resources-for-projects/reporting-forms). It is expected that this report will be a **maximum** of 20 pages in length, excluding annexes)*

Darwin Project Information

Project reference	23-021
Project title	Promoting biodiversity in sustainable oil-palm landscapes for West African smallholders
Host country(ies)	Ghana
Contract holder institution	University of Leeds, UK
Partner institution(s)	Nature Conservation Research Centre, Ghana University of York, UK Kwame Nkrumah University of Science and Technology, Ghana Solidaridad, West Africa Roundtable for Sustainable Palm Oil, Malaysia
Darwin grant value	£327,744
Start/end dates of project	1st April 2016/31 March 2019
Project leader's name	Keith Hamer
Project website/blog/Twitter	http://www.fbs.leeds.ac.uk/staff/Hamer_K/ http://www.sensorproject.net/project/promoting-better-yields-and-biodiversity-in-ghanaian-smallholdings/ Numerous tweets from project staff tagged @Darwin Defra
Report author(s) and date	Keith Hamer, Rebecca Asare, Jane Hill (Project Steering Committee); June 2019

1 Project Rationale

Palm oil is a globally important edible oil that governments in western Africa are increasingly targeting as a key sector for agricultural growth and to address rural poverty. Most oil-palm growers in the region are smallholder farmers who rely on cultivation for both income and household consumption. For instance in Ghana, ~90% of the land cultivated for oil-palm (~400,000ha) comprises smallholdings. Ghana also supports >550 species of rainforest birds, of which about 20 are globally threatened according to the IUCN, and >900 species of butterflies, of which about 100 are endemic to western Africa and threatened by forest loss. Ghana plans to expand smallholdings by a further 150,000 ha over the next 5-10 years, making it vital to provide smallholders with tools and guidance to help them develop sustainable agricultural practices that optimise economic returns, reduce biodiversity losses and environmental threats, and ensure the protection of high conservation value rainforest.

Growing markets in sustainably-sourced palm oil provide ideal opportunities for smallholders in Ghana to boost their incomes through take-up of best agricultural practice (BAP) to increase

yields, reduce economic and environmental costs of reliance on fertilizers and pesticides, and increase crop value through RSPO-certification as sustainable growers. Certification also ensures a commitment by smallholders to the continued protection of rainforest that supports high conservation values (HCVs). However, smallholder uptake of both BAP and RSPO-certification is very low, largely through uncertainties over the yield benefits attainable from BAP, poor knowledge of how to apply BAP, and a lack of scientifically-robust and cost-effective means for smallholders to identify and prioritise HCV-forest for sustained protection, as required for certification. By addressing these issues, this project aimed to promote sustainable oil-palm cultivation that boosts smallholders' incomes and ensures the long-term protection of rainforest supporting high biodiversity.

The project focused on two smallholder communities in the villages of Assin Juaso and Assin Homaho in the vicinity of Assin Foso, a small township in the Central Region of Ghana (Plate 1). These two villages are embedded in a mixed agricultural landscape comprising a diverse range of herbaceous and tree crops, together with patches of forest of varying size and integrity, including Kakum National Park covering an area of 375 square kilometres.

Plate 1. Map of Ghana showing location of focal smallholder communities (blue circle)

2 Project Partnerships

This project arose from presentations and discussions during an international workshop on oil palm held at the University of Leeds in 2015 and attended by several project partners. All partners were involved in planning the project and recognized its importance from the outset, as attested by their letters of support accompanying the original grant application. The partnership was then formalised and cemented by a written Academic Partnership Agreement, signed by representatives from each partner institution (Annex 7.1). The project Steering Committee, comprising members from three of the project's six partner institutions, met regularly throughout the project to continue planning and evaluating progress, including Skype meetings approximately every three months and annual or twice-annual face-to-face meetings in Ghana.

Plate 2: Project partners discussing sampling protocols for biodiversity and environmental variables in high-conservation-value forest in Kakum National park.

Meetings in Ghana were accompanied by discussions with remaining project partners, often over a period of several days in the field, for further planning and evaluation of progress (Plate 2).

Particular strengths with this partnership are: the complimentarity in the skills, experiences and interests of the different partners; the establishment of a Project Steering Committee at the outset of the project to oversee planning and evaluation of progress; the clearly-defined roles of each partner, and; the key role of NCRC as Project Co-ordinator in Ghana. All project partners were involved in preparing this final report and our partnership is set to continue through both further planned projects and additional project outputs including integrating our findings with those of a separate project on shade-grown cocoa to consider broader perspectives within mixed agricultural landscapes.

3 Project Achievements

3.1 Outputs

The project achieved each of its intended Outputs as detailed below:

Output 1: Two Darwin Research Fellows from project partner organizations trained to design and carry out field experiments and to analyse, interpret and report data obtained.

Two graduate Darwin Research Fellows (DRFs; Linda Ofosuhene and Michael Sasu) were recruited to the project from partner organizations NCRC and KNUST at the start of the project. The DRFs each registered full-time for an MSc by Research at the University of Leeds, commencing October 2017. This entailed them each spending 15 months in the UK under direct supervision of the Project Leader, receiving appropriate training, completing identification of >15,000 invertebrate biodiversity samples and writing up their results before submitting their theses in September 2018. Progress was monitored and recorded online via the Graduate Record of Achievement and Development (GRAD) system (https://research.leeds.ac.uk/), including written records and action plans of monthly supervisory meetings (Annex 7.2) and evaluation by an independent assessor of a 4-month report and viva-voce examination (Annex 7.3). Additional training successfully completed by each DRF included a two-week course in advanced statistics using *R* at Leeds, training in mounting and curation of insect specimens to contribute to permanent reference collections, and a 10-day advanced course in identification of African ants at the Witts Rural Facility, Hoedspruit, South Africa (11-16 March 2018), run by Dr Kate Parr, University of Liverpool, UK (Plate 3; **Logframe Indicator 1.1**).

"Participants on our South African ant course: industrious as the ants they are mounting"

Plate 3. Tweet by Dr Kate Parr from 13th March 2018 showing DRFs Michael Sasu and Linda Ofosuhene at an advanced ant identification course in South Africa.

Both DRFs submitted their theses on time, entitled '*Factors that influence yields in oil palm smallholdings in Ghana*' (Linda Ofosuhene) and '*Explaining patterns in biodiversity on smallholder oil palm farms in Ghana*' (Michael Sasu; see Annexes 7.4 and 7.5 for thesis summaries). Reports of these findings (based on Policy and Practice Briefings; Annexes 7.6 & 7.7) will also be uploaded to our RSPO SEnSOR (Socially and Environmentally Sustainable Oil Palm Research) website (http://www.sensorproject.net/reports/; **Logframe Indicator 1.2**) to accompany publication of findings in the international peer-reviewed literature. Each DRF was formally assessed via a viva voce examination by a panel comprising both external examiners (Prof Jos Barlow, University of Lancaster and Dr Richard Davies, University of East Anglia) and internal examiners (Dr Chris Hassall and Dr Steve Sait, University of Leeds). Examiners' reports were both very positive (Annexes 7.8 and 7.9) and both DRFs have now been awarded their MSc by Research degrees and are due to receive their degree certificates at a formal graduation ceremony at the University of Leeds in July 2019 (**Logframe Indicator 1.3**).

Output 2. Measurement and authentication of increases in Fresh Fruit Bunch yield, income and biodiversity resulting from Best Agricultural Practice

The Best Agricultural Practice (BAP) experiment was completed on schedule in July 2017, with data collected using standardised protocols at a total of 92 research plots across the smallholdings in the experiment and in adjacent rain forest. This entailed: (i) Establishing contact with our two focal smallholder communities and holding initial workshops in each village to explain the project's aims and approach (July 2016; Plate 4); (ii) Obtaining ethical approval from the University of Leeds Research Ethics Committee, following a thorough ethical review of the project (August 2016; Annex 7.10); (iii) Completion, approval and signing of a comprehensive Fieldwork Risk Assessment and Data Management Plan (August 2016; Annexes 7.11 & 7.12);

(iv) One-to-one interviews with >100 smallholders expressing interest in participating in the project, including dissemination of Smallholder Information Sheets (Annex 7.13) and signing of Consent Forms (Annex 7.14) prior to structured interviews and completion of smallholder questionnaires (Annex 7.15), and; (v) Assignment of smallholders to one of two treatment groups (implementation of BAP or not), followed by site visits to confirm characteristics of smallholdings in each treatment (September – December 2016; Plate 5).

Plate 4. Tweet from 26 July 2016 showing project partners Keith Hamer, Rebecca Asare and Winston Asante with smallholders in Assin Juaso.

We also obtained quantitative data on yields (number and combined weight of fresh-fruit bunches) obtained by every smallholder in the experiment at each harvest, stratified by month (Annex 7.16; **Logframe Indicator 2.1**). These data were obtained by employing a member of each smallholder community equipped with suitable measuring equipment, rather than by self-reporting by farmers, ensuring that data were independent, quantitative and objective.

Plate 5. Contrasting oil palm treatments; normal practice (left) and Best Agricultural Practice (right), including regular weeding, pruning, contouring of soil to reduce rain water runn-off and deployment of pruned fronds between palms as a source of natural fertilizer.

Quantitative field data were collected on environmental conditions (temperature, light, vegetation structure and soil) and biodiversity (birds, ants, butterflies, moths and termites) using standardised protocols at a total of 92 research plots across the smallholdings in the experiment and in rain forest (February – July 2017; Plate 6; **Logframe Indicator 2.2**). Vegetation structure data comprised sizes and densities of large trees (diameter at breast height [dbh] > 30cm), small trees (dbh 10-30 cm) and saplings (dbh < 30 cm), together with herbaceous vegetation height and ground cover. Soil samples were collected at depths of 0-15 cm and 15-30 cm at representative locations beneath oil palm on each farm, for comprehensive laboratory analysis of key mineral elements, organic matter, pH and structure at KNUST (Annex 7.17). Birds were sampled during fine weather using two 15-minute point counts (one at 5:30 – 8:30am, the other at 15:00 – 18:00) at each research plot, carried out with the assistance of a local bird expert (Mr Ben Ossom). Butterflies and moths were sampled using traps baited with rotting fruit and hung in the understory (two traps for six days at each plot, giving 1104 trap-days in total). Species that could not be identified reliably in the field were collected and, where possible, identified in the laboratory, with the identities of difficult species in the genus *Bicyclus* confirmed by an expert in the taxonomy of this group (Dr Oskar Brattström, University of Cambridge; http://www.bicyclus.se/). Ants were sampled using unbaited pitfall traps (10 traps per research plot for three days each, giving 2760 trap-days in total) and were identified in the UK with the assistance of an expert in African ant taxonomy (Professor Kate Parr, University of Liverpool; http://funkyant.weebly.com/research.html), with mounted and labelled voucher specimens in

each case (**Logframe Indicator 2.2**). Termites were sampled by timed hand-sorting of four 1m^2 soil samples at each research plot. Identification from external morphology has proven challenging and so we are now developing and testing an alternative approach based on molecular analysis of DNA; initial results are promising and we hope to complete this analysis and publish our findings in 2019 or 2020.

Plate 6. Sampling butterflies and moths (left) and identifying a collected specimen (right)

Fresh-fruit bunch yield data indicated that smallholders in our study attained an average yield of 5.7 t ha^{-1} yr^{-1}, which was very similar to the overall average for smallholders in Ghana (5.8 t ha^{-1} yr^{-1}). Yields were increased significantly through adoption of best agricultural practices, in particular contouring of soil around palms to reduce rainwater runoff, with the highest yields (up to 17 t ha^{-1} yr^{-1}) indicating a potential three-fold increase. Given the average size of each smallholding (~2 ha) this increase translates into an average potential additional household income of ~£1,300 yr^{-1}, based on a price of 400 GHC (£57) tonne^{-1} paid for FFBs at the mill gate (**Logframe Indicator 2.3**). In practice, however, few smallholders realised this potential in full, largely because low access to labour to assist with harvests meant that while palms were producing more fruit, these were harvested insufficiently frequently. In addition, smallholders often retained large trees on their farms, particularly of commercially valuable species, and palms shaded by these large trees had significantly lower yields (4.75 ± 3.40 t ha^{-1} yr^{-1} compared to 7.43 ± 4.12 t ha^{-1} yr^{-1} without shading; general linear model [GLM]; $F_{1,29}$ = 5.55, P = 0.02). Moreover, while adoption of BAPs resulted in some improvement in soil quality, concentrations of soil phosphorous and nitrogen were still far below those recommended. For instance, the average for phosphorous was < 6 mg kg^{-1} compared to a minimum of 15 mg kg^{-1} considered suitable to support fruit production. Hence even the highest yields obtained in our study were below those potentially achievable in Ghana using high input methods (up to 25 t ha^{-1} yr^{-1}).

Biodiversity records include 1,350 birds of 78 species (Annex 7.18), 12,568 ants of 76 species (Annex 7.19) and 768 butterflies of 70 species (Annex 7.20). We also recorded 1,813 moths of 89 species, although identification of some specimens has yet to be confirmed. Across taxa, ~60-80% of those species recorded in forest were also present in oil palm, compared to only ~15-30% for industrially grown oil palm elsewhere. In addition while rarefied species richness, taking account of variation in the numbers of individuals recorded in each habit, was significantly higher in forest than in oil palm for birds (Figure 1; note non-overlapping confidence intervals), there was no significant difference between habitats for either butterflies or ants. These data suggest that oil palm smallholdings in Ghana, where oil palm occurs as a natural component of moist lowland forest, are capable of supporting a relatively high proportion of forest biodiversity, particularly in comparison with industrial plantations in SE Asia and elsewhere.

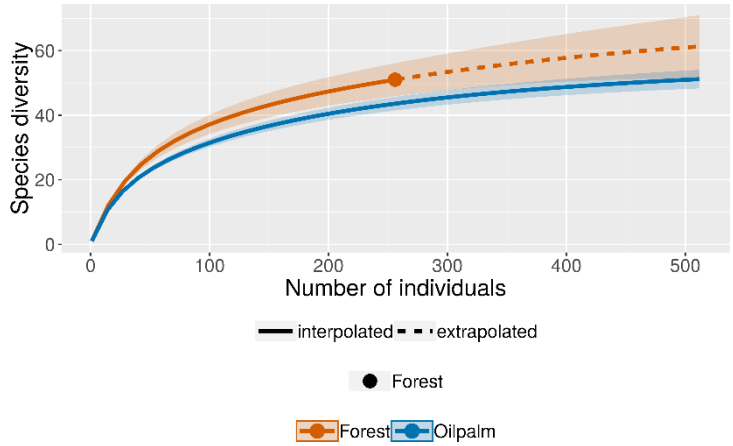

Figure 1. Bootstrapped mean species richness of birds in relation to the number of individuals sampled in protected forest and oil palm. Shaded areas show 95% confidence intervals in each case.

Plot-level species richness of birds, butterflies and ants all varied significantly among smallholdings (GLM; $P \leq 0.002$ in each case) but none differed significantly in relation to adoption of BAP (Table 1; $P \geq 0.5$ in each case). Moreover, a high proportion of those forest species that were supported by non-BAP oil palm were also present in BAP oil palm. For instance, of 28 species of bird recorded in forest and oil palm, only three species (black-throated coucal *Centropus leucogaster*, Klaas's cuckoo *Chrysococcyx klaas* and olive-green camaroptera *Camaroptera chloronata*) were absent from BAP oil palm, and all three are categorised by the IUCN as of least concern. Similarly, of 38 species of ant recorded in forest and oil palm, only four species were absent from BAP oil palm, while of 59 species of butterfly recorded in oil palm, 10 species were confined to non-BAP plots and 15 species to BAP plots. These data indicate that BAP may allow large gains in FFB yield with little additional cost in terms of biodiversity.

Table 1. Species richness of focal taxa at study plots on farms that did or did not adopt Best Agricultural Practice.

	Adoption of BAP			
	Yes (n = 40)		No (n = 40)	
	Mean	SD	Mean	SD
Birds	7.70	2.12	8.40	2.35
Butterflies	5.90	3.44	5.45	3.06
Ants	11.08	3.83	10.80	4.03

Averaged across study plots on each farm, species richness of birds was higher on farms that retained large trees above the oil palm canopy (mean = 10.3 ± 2.2 species station^{-1}) than on those that did not (8.2 ± 1.8 species station^{-1}; $t_{29} = 2.68$, $P = 0.01$), resulting in a significant negative relationship between $\log_{10}$ FFB yield and species richness of this taxon (Figure 2; GLM; $F_{1,29} = 5.14$, $P = 0.03$). These data indicate that obtaining the highest yields by removing shade trees may incur some biodiversity cost. However, species richness of butterflies was significantly *lower* on farms that retained large trees than those that did not (3.3 ± 2.0 and 5.9 ± 2.8, respectively; $t_{29} = 2.31$, $P = 0.028$), indicating opposite effects of removing large trees on the species richness of butterflies and birds. Summaries of these findings will be published in a science-for-policy report at http://www.sensorproject.net/reports/ following publication of the full results in the international peer-reviewed literature (**Logframe Indicator 2.3**; anticipated publication before end of 2019).

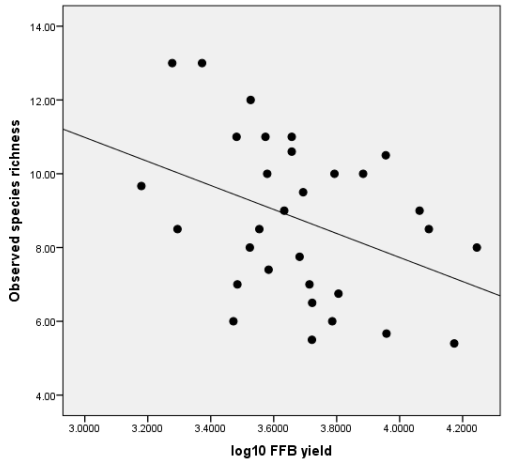

Figure 2. Mean species richness of birds at study plots on farms with different FFB yields.

Output 3. More than 1000 smallholder farmers, comprising men and women equally, have raised awareness of benefits and better knowledge of how to apply Best Agricultural Practice, including robust land-use planning to identify, prioritise and protect HCV forest.

Knowledge of how to apply Best Agricultural Practice and appreciation of its benefits has increased substantially among our focal communities of smallholders (>500 in total), as evidenced by their strong participation in our end-of-project community knowledge-exchange workshops (very well attended by both men and women; Plate 7; **Logframe Indicator 3.2**) and by the large number who confirmed that they have adopted BAP on their smallholdings (54% of women and 65% of men among 96 smallholders surveyed; Annex 7.21; **Logframe Indicators 3.1 & 3.3**). In addition to lively discussion and question-and-answer sessions based around our written knowledge dissemination and training materials (Policy & Practice Briefings; Annexes 7.6 and 7.7), workshops also included dialogue with staff from the Ghanaian Ministry of Food and Agriculture (including from the Directorate of Agricultural Extension Services; Mr Jonathan McCarthy) and the Ghanaian Wildlife Service (including the local Head of Wildlife, Mr Mohammed Adams). As a result of this dialogue, those smallholders adopting BAP have now registered with a newly-established nationwide programme of Best Agricultural Practice (the Oil Palm Development Association of Ghana; OPDAG) overseen by the Ministry of Food and Agriculture, providing ongoing technical support and advice in return for agreement by farmers to maintain BAP within their smallholdings and comply with agreements to protect high conservation value forest (membership registration form at Annex 7.22; these were completed by smallholders during and after our workshops).

Darwin Initiative fellows Linda Ofusuhene & Michael Sasu discuss with oil palm smallholder farmers how to increase yields without reducing biodiversity
@Darwin_Defra @KeithCHamer @RSPOtweets @Winston Asante @SensorProgramme

Plate 7. Tweet from one of our end-of-project community knowledge-exchange workshops, showing (right) discussion of our smallholder Policy & Practice Briefings (Annexes 7.6 & 7.7) and (left) dialogue with our two Darwin Research Fellows

Output 4. More than 500 smallholder farmers form associations and support networks, receive assistance with costs of certification from RSPO and use this to apply successfully for certification.

Our focal communities of smallholders (>500 in total) have each formed very effective associations and support networks (**Logframe Indicator 4.1**) including the Aseda Oilpalm Association in Assin Breku (Chair, Emanuel Achimpong; Secretary, Daniel Amoanah; both members of the local smallholder community), which is now recognised by the Ghanaian Ministry of Food and Agriculture as a Flagship Association to support their newly-established programme of Best Agricultural Practice in oil palm (see Output 3 above). These networks are forming the main route for dissemination and exchange of information with our project partner Solidaridad, who are providing ongoing support and assistance to smallholders with RSPO certification (**Logframe Indicator 4.2**). In practice, certification will now be obtained by the new palm oil mill opened by Solidaridad in Assim Foso in 2016 (Plate 8) rather than by the smallholders directly. This greatly facilitates certification and helps ensure that both the growing of oil palm and the processing of fruit to produce palm oil adhere to RSPO sustainability principles and criteria, including protection of high-conservation value forest. The process of mill certification is well in hand and on target to be completed by 2020 (**Logframe Indicator 4.3**).

Plate 8. A typical palm oil mill (left) and the modern mill opened by project partner Solidaridad in 2016 (right). This has not only increased capacity and improved working conditions but also produces much higher-quality oil, potentially giving access to international markets.

Output 5. Evidence and lessons learned from project disseminated to policy makers in Ghana and internationally.

Project findings were disseminated and discussed at an end-of-project impact workshop attended by Ghanaian policy makers and other stakeholders from the Ministry of Food and Agriculture (Kwesi Abaka-Quansah, Assistant Director), the Environment Agency (Ruffina Atanga), the Convention on Biological Diversity Committee (Eric Okoree, Coordinator, and colleagues), the Crop Research Institute (Dr Stella Ennin, Former Director), the Forestry Commission (Raymond Sakyi, Climate Change Unit), Proforest (Nana Kwabena Darko) and the oil palm industry (Victor Tetteh Zutah, Research Manager, Benso/Wilmar Oil Palm Plantations), in addition to project partners (Plate 9; **Logframe Indicator 5.3**). Discussions centred around Powerpoint presentations and written policy and practice briefings (Annexes 7.6 & 7.7), ensuring focused consideration of both oil palm yields and biodiversity, and resulting in broad agreement of the need to recognise biodiversity and ecosystem services in policy and advice on BAP (**Logframe Indicator 5.1**).

Discussing with policy makers how to raise smallholder oil palm yields & livelihoods @Darwin_Defra @Solidaridad_wa @proforest @KeithCHamer @myk @lyndalopez12 @RSPOtweets @SensorProgramme @YESIUoY #NCRC

Plate 9 Tweet from our end-of-project Impact workshop

In addition, evidence and lessons learned from the project have been or will be disseminated broadly to a variety of international audiences (**Logframe Indicator 5.2**) via diverse means including: (i) online publication of science-for-policy reports (http://www.sensorproject.net/); (ii) presentation of information at RSPO Roundtables in 2017 and 2018 (including an information booth within the conference hall, providing a very effective means of face-to-face discussion and knowledge exchange with conference delegates, and representing the 'voice of smallholders' in a dedicated conference session on RSPO Principles and Criteria; https://www.rt.rspo.org/c/rt15-programme/); (iii) presentations by four project partners and both DRFs at an international workshop on sustainable palm oil (University of Sheffield, UK, May 2018; Annex 7.23, and; (iv) Powerpoint presentations by two project partners at the following five international meetings and conferences:

2019 Association of Tropical Biology & Conservation, Antananarivo, July.
'Unifying Tropical Ecology' BES/GTÖ symposium, Edinburgh, April. Plenary presentation.
2018 'EFforTS' symposium (DFG; University of Göttingen), Bali, October. Plenary presentation.
Association of Tropical Biology & Conservation, Kuching, July. Invited symposium presentation.
2017 Association of Tropical Biology & Conservation, Merida, July.

3.2 Outcome

The intended outcome of this project was 'Improved agricultural practices increase incomes of Ghanaian oil-palm smallholders, boost biodiversity within smallholdings and adjacent forest, promote sustainability certification by smallholders and ensure robust land-use planning to protect high-conservation-value rainforest'. Our project achieved this outcome, as evidenced by the Logframe Measurable Indicators (LMIs) and Means of Verification detailed below:

LMI 0.1 In our Best Agricultural Practice experiment, oil palm (fresh fruit bunch) yields of smallholder farmers adopting best agricultural practice increased by up to 200% compared to the non-BAP mean, translating into an additional household income of up to ~£1,300 yr^{-1} (details in Section 3.1 Output 2 above). These increases were in keeping with or greater than those anticipated in our logframe indicator (50-100% increase in yield, £900 - £1800 increase in household income). This information is published in an independently peer-reviewed MSc by Research thesis (summary in Annex 7.4) and will be included in a science-for-policy report at http://www.sensorproject.net/reports/. An example of the monthly fresh fruit bunch yield data obtained during the experiment is also shown in Annex 7.16: the complete data set will accompany a peer-reviewed research paper detailing our findings, to be submitted in summer 2019. An important assumption identified in our logframe was that there is access to markets for additional oil palm yields. Through our project, we identified a key constraint that while BAP boosts production of fruit, smallholders often lack the capacity to harvest this additional fruit sufficiently quickly; hence there is a distinction between making and taking of yields. To solve this problem, our project partner Solidaridad will now employ members of the local community to

assist with fruit harvests, in return for a small discount in the price paid to smallholders for fruit by the local oil palm mill opened by Solidaridad in 2016 (Section 3.1 Output 4, Plate 8 above).

LMI 0.2 Adoption of BAP had little or no discernible adverse effect on the species richness of birds, butterflies or ants within oil palm. This information is published in an independently peer-reviewed MSc by Research thesis (summary in Annex 7.5) and will also form the basis of a science-for-policy report at http://www.sensorproject.net/reports/, to be published alongside a peer-reviewed research paper detailing our findings, to be submitted in summer 2019. An example and summaries of the biodiversity data obtained during the experiment are shown in Annexes 7.18 – 7.20: the complete data sets for all taxa will be published to accompany the full results in the peer-reviewed literature. An important assumption identified in our logframe was that current levels of bird and insect biodiversity in smallholdings can be enhanced by BAP. This was itself based on the assumption that only a small proportion (~15-30%) of forest species would be present in non-BAP oil palm, based on the proportions recorded in industrial oil palm plantations elsewhere. In contrast, we found that across taxa, ~60-80% of those species recorded in forest were also present in oil palm (details in Section 3.1 Output 2 above). Hence the main reason why BAP did not boost biodiversity was probably that it was already much higher than expected for oil palm, reflecting its status as a natural forest species in West Africa. Nonetheless our results clearly show that BAP may allow large gains in fresh fruit bunch yields with little cost in terms of biodiversity.

LMI 0.3 Knowledge of how to apply Best Agricultural Practice and appreciation of its benefits has increased substantially among our two focal communities of smallholders (>500 in total), among whom 54% of women and 65% of men surveyed have now adopted BAP (details in Section 3.1 Output 3 above; material used in end-of-project community knowledge-exchange workshops in Annexes 7.6 & 7.7). In addition the Ministry of Food and Agriculture in Ghana has established a new nationwide programme in Best Agricultural Practice (OPDAG; details in Output 3 above) and has set a target of 15,000 smallholders to be registered with this programme by the end of 2019 (J McCarthy pers. comm.), providing a very effective means for much broader dissemination and uptake of our project findings and advice.

LMI 0.4 Our focal communities of smallholders have each formed very effective associations and support networks forming the main route for dissemination and exchange of information with our project partner Solidaridad, who are providing ongoing support and assistance to smallholders with RSPO certification, including agreement to protect high conservation value forest. In practice, this certification will now be obtained by the new palm oil mill opened by Solidaridad in Assim Foso in 2016 rather than the smallholders directly (details in Section 3.1 Output 4 above).

3.3 Impact: achievement of positive impact on biodiversity and poverty alleviation

Our proposed impact was: Promotion of sustainable agriculture to improve rural livelihoods and protect biodiversity. We have achieved this impact by:

(1) Providing a sound evidence-base quantifying the potential uplift in oil palm smallholders' fruit yields and incomes through adoption of Best Agricultural Practice (**logframe indicators 0.1 and 2.1**; evidence detailed in Section 3.2 Outcome 0.1 above);

(2) Providing a complimentary evidence-base comparing the biodiversity of birds, ants, and butterflies in oil palm and high conservation value forest, and quantifying how the adoption of Best Agricultural Practice affects biodiversity within oil palm (**logframe indicators 0.2 and 2.2**; evidence detailed in Section 3.2 Outcome 0.2 above);

(3) Disseminating this information to the focal smallholder communities in our study, the Ghanaian Ministry of Food and Agriculture (who have now adopted one of our focal communities as a 'flagship' association in their newly-established nationwide programme of Best Agricultural Practice targeting >15,000 smallholders) and more broadly to a wide range of GOs, NGOs and other stakeholders (**logframe indicators 3.1 to 3.3 and 5.1 to 5.3**; evidence detailed in Section 3.2 Outcome 0.3 above);

(4) Providing assistance to smallholder communities, formed into effective Smallholder Oil Palm Associations, with the process of RSPO certification as sustainable growers, through the new fully-mechanised palm oil mill opened by our Project Partner Solidaridad during the course of the project (**logframe indicators 4.1 to 4.3**; evidence detailed in

Section 3.2 Outcome 0.4 above). This new mill: (i) has greatly increased the speed, efficiency and quality of palm oil production, allowing access to international markets for the first time (once harvested, fruit need to be processed within 24hrs to prevent production of free fatty acids, which taint the oil. This was not previously possible but is essential for international trade); (ii) employs members of the local community in greatly improved working conditions (Plate 8 above), and; (iii) will now provide assistance to smallholders with regular harvesting of fruit, thus solving a key constraint identified by this project (details in Outcome 3.2 above) in addition to providing additional employment to members of the local community.

Among our focal smallholder communities, an estimated 60% (54% of women, 65% of men) have so far adopted Best Agricultural Practice, generating additional oil palm (fresh fruit bunch) yields of up to 200% (up to 17 tonnes ha^{-1} $year^{-1}$ against a baseline of 5.8 tonnes ha^{-1} $year^{-1}$), translating into an average potential additional household income of ~£1,300 yr^{-1}. This direct contribution to poverty alleviation is in addition to improved working conditions for both smallholders and mill workers processing fruit into palm oil (see Plate 8 above).

4 Contribution to Darwin Initiative Programme Objectives

Our project directly supports SDGs 1 (no poverty), 2 (zero hunger), 8 (sustainable economic growth), 12 (responsible consumption and production) and 15 (life on land). We have promoted the uptake and retention of Best Agricultural Practice in our focal smallholder communities, targeted at increasing fruit yields, decreasing reliance on environmentally damaging agrochemicals and supporting farmland biodiversity. We have also quantified relationships between crop management and yields, income and biodiversity (see Section 3.2 above; **logframe indicators 2.2 and 2.3**); evidence that is vital to underpin policies and goals promoting the wider uptake of Best Agricultural Practice and certification as sustainable producers (**logframe indicators 4.2 and 4.3**).

4.1 Project support to the Conventions or Treaties (CBD, CITES, Nagoya Protocol, ITPGRFA)

Our project has supported Ghana in meeting its objectives under the CBD by contributing to all five Strategic Goals of the Aichi Biodiversity Targets. We have:

Goal A

Raised awareness of the values and sustainable use of biodiversity (Target 1), integrated biodiversity values into poverty reduction strategies (Target 2) and enhanced sustainable crop production within safe ecological limits (Target 4);

Goal B

Enhanced the sustainable management of agriculture, helping to ensure conservation of biodiversity (Target 7) and bringing pollution, including from excess nutrients, to levels that do not harm ecosystem function and biodiversity (Target 8);

Goal C

Enhanced effective area-based conservation measures, fully integrated into the wider landscape (Target 11);

Goal D

Enhanced and safeguarded benefits of ecosystems services to the poor and vulnerable (Target 14);

Goal E

Enhanced scientific knowledge of biodiversity and consequences of its loss (Target 19).

We have made a particular contribution towards the following Achi targets:

Target 1: People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably. We have promoted the importance of biodiversity and ecosystem services widely among smallholders, policy makers and other stakeholders. This includes dissemination of management briefs for smallholders and policy briefs for other stakeholders, outlining how biodiversity can be supported through adoption of Best Agricultural Practice (**logframe indicators 3.2, 5.1**).

Target 2: Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems. We have shown that Best Agricultural Practice generates substantial potential increases in oil palm fruit yields and farmers' incomes with little or no discernible adverse effect on biodiversity. We have disseminated and discussed this information widely among policy makers and other stakeholders, resulting in broad agreement of the need to recognise biodiversity and ecosystem services in policy and advice on BAP (**logframe indicators 2.3, 5.1, 5.2**).

Target 19: Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied. We have provided a sound evidence base comparing the biodiversity of birds, ants and butterflies in oil palm and high conservation value forest and quantifying how the adoption of best agricultural practice affects each of these taxa within oil palm. We have shared these data widely, supported by a fully-catalogued reference collection of ants (**logframe indicators 0.1, 2.1**).

Through these achievements, the project has fulfilled a major aim of Ghana's National Biodiversity Strategy and Action Plan (NBSAP) 'to pursue and promote the necessary international co-operation with donor organizations (and) development partners … to ensure that sound policies are implemented for the sustainable use of biological resources of the nation'.

4.2 Project support to poverty alleviation

Oil-palm production contributes directly to the incomes of more than 3 million people in rural areas of Ghana (~10% of the country's total population) and smallholders contribute over 80% to this production. The sector accounts for much of women's labour, but is characterised by low productivity (less than half that achieved by large estates) and low incomes. By disseminating knowledge and enabling increased adoption of Best Agricultural Practice, this project has already boosted the oil-palm (fresh fruit bunch) yields of our focal smallholder communities (>500 households) by up to 200%, translating into an increase in household incomes of up to ~£1300 per annum while simultaneously reducing reliance on agrochemicals (fertilizers and pesticides) and mitigating soil erosion, surface runoff and risks of flash flooding through improved soil management and better land-use planning. This impact is set to become much broader through a new nationwide programme in Best Agricultural Practice (OPDAG), established by the Ghanaian Ministry of Food and Agriculture in Ghana, with a target of 15,000 smallholders registered by the end of 2019. RSPO certification among smallholder households adopting BAP (estimated 60% to date among our focal smallholder communities) will then provide an additional premium for certified sustainable palm oil (CSPO) based on access to markets. Supporting evidence and logframe indicators are provided in 3.2 Outcome and 3.3 Impact above.

4.3 Gender equality

We promoted gender equality throughout the project including: ensuring gender balance among project partners (four men, four women) and steering committee members (one man, two women); recruiting one male and one female graduate student as Darwin Research Fellows at the start of the project, both of whom obtained Masters Degrees by Research at the same time; ensuring that our Best Agricultural Practice experiment and smallholder surveys included men and women equally, allowing all data to be analysed with explicit reference to gender, and; ensuring as far as possible that men and women were represented equally and made equal contributions to our end-of-project smallholder community knowledge exchange workshops and impact workshop (Plates 7 and 9 above). In terms of impact, we found that male and female

smallholder farmers were equally likely to benefit from adoption of Best Agricultural Practice: our analysis of smallholder questionnaire data found no evidence of any gender difference in constraints on crop management, our analysis of fresh fruit yield data found no sex difference in yields and a broadly similar proportion of men and women have so far adopted Best Agricultural Practice (logframe indicators 1.1, 2.1, 3.1, evidence provided in 3.2 Outcome above).

4.4 Programme indicators

- **Did the project lead to greater representation of local poor people in management structures of biodiversity?**

No; this was not an aim of the project

- **Were any management plans for biodiversity developed?**

No; this was not an aim of the project. However, the project achieved broad agreement among policy makers and other stakeholders of the need to recognise biodiversity and ecosystem services in policy and advice on BAP

- **Were these formally accepted?**

N/A

- **Were they participatory in nature or were they 'top-down'? How well represented are the local poor including women, in any proposed management structures?**

N/A

- **Were there any positive gains in household (HH) income as a result of this project?**

Yes

- **How many HHs saw an increase in their HH income?**

~300 households in focal smallholder communities to date, with anticipated uptake by >15,000 households over coming year.

- **How much did their HH income increase (e.g. x% above baseline, x% above national average)? How was this measured?**

Up to 200% increase in income from oil palm, from a baseline of £660 $year^{-1}$ to £1970 $year^{-1}$, calculated from data on fresh fruit yields and prices paid by mill.

4.5 Transfer of knowledge

New knowledge generated by our project was transferred to practitioners in our focal smallholder communities via our end-of project community knowledge exchange workshops, supported by printed material on impacts of Best Agricultural Practice on fruit yields and biodiversity, and is set to be transferred to a further 15,000+ smallholders nationwide through the Ghanaian Ministry of Food and Agriculture's new programme in Best Agricultural Practice (Output 3 above). Knowledge was also transferred to a wide range of Ghanaian policy makers and other stakeholders through our end-of-project impact workshop in addition to online publication of policy briefs and presentation of information at RSPO roundtables and other international meetings and conferences (Output 5 above). Through the project, two Ghanaian graduate students (Darwin Research Fellows; one male, one female) have obtained the formal qualification of Master of Research from the University of Leeds, UK (Output 1 above).

4.6 Capacity building

In addition to our two Darwin Research Fellows receiving MSc by Research qualifications, Dr Rebecca Asare (Director of Programmes and Research at the Nature Conservation Research Centre Ghana; female) has recently obtained an Africa Oxford Visiting Fellowship to visit the University of Oxford in 2019/20.

5 Sustainability and Legacy

By helping to make smallholder oil-palm production more efficient and sustainable, this project has contributed to creating a “win-win” for poverty reduction and biodiversity conservation and supported Ghana in its CBD commitments. By quantifying for the first time how different agricultural practices boost yields, and disseminating this information widely through our project activities and partner extension services, we have enabled smallholders to make informed choices over the uptake of Best Agricultural Practice, thus removing one of the major impediments to improving smallholders’ livelihoods.

The area of land cultivated by smallholders is likely to increase under Ghana’s Poverty Reduction Strategy. Hence, by promoting practices that support biodiversity within smallholdings as well as increasing oil-palm yields, we have helped to reduce biodiversity losses resulting from any future expansion. By assisting smallholders, through the formation of effective Oil Palm Associations, with the process of RSPO certification via the local oil palm mill newly opened by our project partner Solidaridad, we have also helped ensure that high conservation value forest areas within these agricultural landscapes are fully protected from replacement by oil palm, in adherence to RSPO Principles and Criteria for certification.

All project staff are continuing in their posts. Our two Darwin Research Fellows, trained to MSc level in advanced statistics and experimental design, quantitative census methods, insect identification and taxonomy, spatial modelling techniques and GIS, are also continuing to work for our project partners, ensuring that their skills and knowledge are retained and used in the long term to train others. One DRF (Michael Sasu) has also applied for a PhD scholarship to further enhance his skills and training. Our permanent transects will also facilitate continued monitoring of longer-term biodiversity and soil quality benefits beyond the duration of the project.

6 Lessons learned

The project benefited immensely from the expertise and input of our Ghanaian project partners, especially NCRC. This highlighted the importance of a strong international partnership with very capable, experienced and highly committed partners in the host country. The design of the project was enhanced by refinements to our data collection and analysis. From experience on the ground we recognized that in practice, there was a spectrum of crop management intensities within each of our two experimental treatments. Hence we can incorporate the environmental data collected from each study plot within our analysis, allowing us to quantify relationships between crop management and different response variables much more precisely. If repeating the project, we would take account from the outset of changes to Tier 4 UK Study Visa regulations for overseas students, which no longer permit part-time study in the UK.

6.1 Monitoring and evaluation

One project activity was amended through a formal change request in Yr1, following changes to the UK Home Offiice Tier 4 visa regulations: The DRFs did not visit the UK during the first year of the project as originally planned because overseas students are no longer permitted to study part-time in the UK under Tier 4 visas. They each instead registered full-time for an MSc by Research at the University of Leeds, commencing October 2017. This entailed each DRF spending 15 months in the UK receiving appropriate training as planned, completing identification of invertebrate biodiversity samples and writing up their results before submitting their theses in September 2018. This change was approved following submission of a change request in December 2016 and highlighted in the Year 1 HYR and annual report.

MSc by Research theses submitted by each of our two Darwin Research Fellows were formally assessed via a viva voce examination by a panel comprising examiners from both the University of Leeds (staff not involved in the project) and other UK Universities. Both reports were very positive and both DRFs have now been awarded their degrees (see Section 3.1 Output 1 above).

6.2 Actions taken in response to annual report reviews

Project partners were all pleased that the reviews of our 1st and 2nd annual reports concluded that there was good progress towards completion or our Outputs and Outcome and that these were likely to be largely achieved (Score = 2 in each case). The general assessment after Yr2

highlighted the importance of reporting results on progress towards achieving outcome-level indicators 0.1 and 0.2 (fruit yields, income and biodiversity) in the final report, which we have done in Section 3.2 above.

7 Darwin identity

Our project has a clear identity and is recognized as a Darwin Initiative funded project. We have used the Darwin Initiative logo on all project documentation and Powerpoint presentations at national and international meetings and conferences (e.g. Annexes 7.11 - 7.13). This has increased knowledge and familiarity with the Darwin Initiative, including among university, government and NGO staff working in Ghana. We have and will continue to acknowledge Darwin Initiative funding in all reports and research papers. All project tweets have been tagged @Darwin_Defra.

8 Finance and administration

8.1 Project expenditure

Project spend (indicative) since last annual report	2018/19 Grant (£)	2018/19 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)	55,516	65,106	17%	This variance was mainly due to paying our two Darwin Research Fellows an additional £3,873 each in recognition of their additional work in helping to deliver outputs at the end of the project. This was agreed in advance with LTSI and offset against savings in Overhead and Operating costs and M&E.
Consultancy costs	-	-	-	
Overhead Costs	10,706	9,115	-15%	This underspend was due to our two Darwin Research Fellows spending much of Yr3 in the UK completing thei MSc by Research studies rather than being in Ghana as originally planned. This change was approved following submission of a change request in December 2016 and highlighted in the Year 1 HYR and annual report (see Section 6.1 above).
Travel and subsistence	15,550	20,834	34%	The overspend on T&S and underspend on Operating Costs were simply due to international

				conferences and workshops in Ghana being originally budgeted wholly as operating costs (£20K in total) whereas in practice expenditure on these was assigned partly to travel and subsistence. The total expenditure on fieldwork, conferences and workshops (£35,225) was close to that budgeted (£38,050) with a variance <10%.
Operating Costs	22,500	14,391	-36%	See Travel and subsistence above
Capital items (see below)	-	-	-	
Monitoring and Evaluation	3,950	3126	-20%	We were able to make savings to M&E in Yr3 as a result of sustained good project management including the establishment of a Project Steering Committee at the outset of the project to oversee planning and evaluation of progress (see Section 2 above). We also benefited greatly from the assistance of financial support staff at Leeds University, which was not charged to the project.
Others (see below)	-	-	-	
Audit cost	1,000	1,800	+ 80%	Current rate Lees Audit £1500 plus VAT
TOTAL	109,222	114,372		

Staff employed (Name and position)	Cost (£)
Keith Hamer (Project Leader)	
Guy Ziv (Database Manager)	
Michael Sasu (Darwin Research Fellow)	
Linda Ofosuhene (Darwin Research Fellow)	
Rebecca Asare (Project Co-ordinator)	
Jane Hill (Fieldwork Manager)	
Charles Bandari (Administrative Support)	
TOTAL	

Capital items – description	Capital items – cost (£)
None	
TOTAL	**0.00**

Other items – description	Other items – cost (£)
None	
TOTAL	**0.00**

8.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
University of Leeds	
University of York	
KNUST	
NCRC	
Solidadirad	
RSPO	
TOTAL	

Source of funding for additional work after project lifetime	Total (£)
TOTAL	

8.3 Value for Money

We feel that this project provided very good value for money, for the following reasons: of the total budget needed for the implementation of this project, 64% was provided by the Darwin Initiative and 36% as matching funds from other sources. More than 80% of the Darwin Initiative funding of this project was invested in Ghana. Costs for the two Darwin Research Fellows were based on Masters by Research degree fees at the University of Leeds and stipends equivalent to the maintenance component of RCUK postgraduate studentships. Accommodation for the two Darwin Research Fellows during extensive periods of fieldwork was provided by NCRC at a fraction of total cost, as were two 4x4 vehicles and experienced drivers, essential for reliable and safe transport of personnel, equipment and samples to and from remote fieldwork sites. Salary costs were based on current emoluments and annual incremental adjustments where applicable during the project lifetime, but not inflation. Funds for only a proportion of staff time allocated to the project were requested by project partners, and the remaining costs were met by their respective Institutions.

Annex 1 Project's original (or most recently approved) logframe, including indicators, means of verification and assumptions.

Note: Insert your full logframe. If your logframe was changed since your Stage 2 application and was approved by a Change Request the newest approved version should be inserted here, otherwise insert the Stage 2 logframe.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Impact: Promotion of sustainable agriculture to improve rural livelihoods and protect biodiversity.			
Outcome: Improved agricultural practices increase incomes of Ghanaian oil-palm smallholders, boost biodiversity within smallholdings and adjacent forest, promote sustainability certification by smallholders and ensure robust land-use planning to protect high-conservation-value rainforest.	0.1 Oil-palm (fresh fruit bunch) yields of focal smallholders using Best Agricultural Practice increase by 50-100%, from 3-5 tonnes ha^{-1} $year^{-1}$ to 7-10 tonnes ha^{-1} $year^{-1}$, increasing annual household incomes by an average of 5,000-10,000 GHC (£900-1800) by end of Yr2. 0.2 Bird, butterfly, ant and termite biodiversity within smallholdings using Best Agricultural Practice and adjacent forest, including foraging success of focal bird species, increase by >10% in comparison to controls by end of Yr2. 0.3 Evidence-base of economic benefits of Best Agricultural Practice disseminated to >1000 smallholders together with training in applying BAP, including robust and cost-effective identification and prioritisation of HCV forest for long-term protection, resulting in widespread adoption by Yr 3. 0.4 More than 500 smallholder farmers adopting BAP achieve RSPO certification, including	0.1 Two technical reports and two peer-reviewed publications on key drivers of variation in oil-palm yields and incomes, and on impacts of Best Agricultural Practice on yields and incomes from BAP experiment. 0.2 Two technical reports and two peer-reviewed publications on impacts of Best Agricultural Practice on bird and insect biodiversity from BAP experiment, and on the robustness and reliability of cost-effective measurements of forest characteristics to identify and prioritise HCV forest for long-term protection. 0.3 Material for use at smallholder knowledge-dissemination, training and certification events; report on outcomes of events including smallholder surveys, questionnaires and multiple-choice quizzes. 0.4 Data on applications by Smallholder Associations for RSPO-certification, success rates of applications, and price premiums paid to certified growers provided by	1. Current oil-palm fresh fruit bunch (FFB) yields are below maximum and can be substantially increased. Discussions with our project partners indicate that average yields are currently below half those achieved on industrial plantations in the region, and that this is largely the result of poor agricultural practices of smallholders. 2. There is access to markets for additional oil-palm yields. The rapid and sustained increased in global demand for certified palm oil indicates this is very likely. 3. Current levels of bird and insect biodiversity in smallholdings and adjacent forest can be enhanced by BAP. Available evidence indicates this is the case for other crops (e.g. coffee, cocoa) and hence is likely to also be the case for oil-palm. 4. Adoption of BAP will enable smallholders to achieve RSPO certification. We will work closely with smallholder communities, palm oil estates wishing to get their smallholder out-growers certified and

	approval of plans for identifying and conserving HCV forest, by Yr 3.	project partners RSPO and Solidaridad.	RSPO agencies to facilitate this process, drawing extensively on the considerable expertise and successful experience of our project partners at Solidaridad, and making full use of RSPO funds (their Smallholder Support Fund, RSSF,) specifically for this purpose. 5. Smallholders adopting BAP will not subsequently increase the area under cultivation at the expense of high-conservation-value rainforest. In practice, the area of land given over to oil-palm cultivation by smallholders is set for a large increase under Ghana's Poverty Reduction Strategy, and so promoting effective land-use planning as a key component of BAP for both established smallholdings and new plantings is more important than ever. RSPO certification will ensure that high conservation value forest within areas designated for expansion is fully protected from replacement by oil-palm, whereas it is currently highly vulnerable.
Outputs: **1**. Two Darwin Research Fellows from project partner organizations trained to design and carry out field experiments and to analyse, interpret and report data obtained.	1.1 DRFs successfully complete MRes modules in advanced statistics and experimental design, quantitative census methods, avian and insect identification and GIS. 1.2 DRFs each write up two reports on data and findings arising from BAP experiment, which are up-loaded onto the RSPO website.	1.1 Transcripts and marks for module assessments, approved by MRes exam board. 1.2 Four reports uploaded to RSPO website. 1.3 MRes degree certificates and classifications (Pass, Merit or Distinction). Papers published in peer-reviewed journals and freely accessible via the White-Rose Open	DRFs and smallholders can be recruited to the project and remain active and fully committed to its aims and objectives. This will be greatly enhanced by the strong links between project partners and the extensive experience and expertise of Ghanaian partners in working with rural farming communities.

	1.3 DRFs are each awarded MRes degrees and co-author a minimum of four peer-reviewed open access publications quantifying the FFB yield, income and biodiversity benefits of improved agricultural practices.	Access repository of scientific papers.	
2. Measurement and authentication of increases in Fresh Fruit Bunch yield, income and biodiversity resulting from Best Agricultural Practice, and of the usefulness of easily-obtained measures to identify HCV forest for land-use planning.	2.1 Monthly records of oil-palm income (quantity of FFBs sold and price from mill) from control (current management) and experimental (Best Agricultural Practice) plots of 40 smallholders in BAP experiment, together with report on socio-economic and logistical constraints on both women and men from realizing income benefits of increased FFB yields. 2.2 Permanent transects established and census data (species richness, abundance and composition) obtained for birds and insects in experimental and control plots of 40 smallholders in BAP experiment and adjacent forest plots. Additional census data on topographical and vegetation characteristics of study plots in forest. Database on foraging behaviour of focal bird species within oil-palm in experimental and control plots. Fully catalogued reference collections with online databases for new species. 2.3 Published data quantifying the FFB yield, income and biodiversity benefits of Best Agricultural Practice for oil-palm smallholders in target communities, and the relationships	2.1 Excel Workbook with spreadsheets of monthly records; report uploaded to project website. 2.2 Database of results of BAP experiment including bird and insect records published and freely accessible via project website and Global Biodiversity Information Facility. Insect reference collections deposited at KNUST, with full descriptions, images and accession numbers of new species in global online databases. 2.3 Papers published in peer-reviewed journals and freely accessible via the White-Rose Open Access repository of scientific papers, with supporting data deposited in a freely-available data repository (e.g. Dryad).	BAP experiment will yield clear results showing publishable benefits of BAP for biodiversity. Our previous research elsewhere supports the notion that birds and insects respond quickly and are sensitive to habitat improvements.

	between topographical and vegetation characteristics of forest and biodiversity.		
3. More than 1000 smallholder farmers, comprising men and women equally, have raised awareness of benefits and better knowledge of how to apply Best Agricultural Practice, including robust land-use planning to identify, prioritise and protect HCV forest.	3.1 Before-and-after surveys of smallholders participating in Best Agricultural Practice experiment show measured increases in scores for importance of and satisfaction with BAP, equally among women and men. 3.2 >1000 smallholders attend knowledge dissemination and training events held within smallholder communities and with smallholder out-growers at oil-palm estates. 3.3 Multiple-choice quizzes completed anonymously by smallholders at start and end of knowledge dissemination and training events show measured increases in average scores, equally among women and men.	3.1 Anonymised results of before-and-after surveys, stratified by gender, uploaded to project website with accompanying report summarising analysis and findings. 3.2 National and social media coverage of smallholder knowledge-dissemination and training events, plus written material used at these events uploaded to project website. 3.3 Results of questionnaires and multiple-choice assessments of training outcomes at these events, with reports, uploaded to project website.	>1000 smallholders, comprising men and women equally, will attend knowledge dissemination and training events, and complete anonymised multiple choice assessments. Our project partners' extensive experience of working with rural farming communities in Ghana strongly suggests that this will be the case.
4. More than 500 smallholder farmers form associations and support networks, receive assistance with costs of certification from RSPO and use this to apply successfully for certification.	4.1 Local smallholder associations and support networks share good practice and knowledge, linked by text messaging networks, social media sites or alternatives as preferred by each community. 4.2 Each smallholder association applies successfully for assistance from RSPO's Smallholders Support Fund (RSSF), assisted by community-based certification events and supported by a handbook on achieving RSPO-certification.	4.1 Facebook pages, twitter accounts and tweets, or alternatives as preferred by each community. 4.2 Material used at certification events, including handbook on achieving certification, uploaded to project website. Annual reports from RSPO on numbers and outcomes of applications by Smallholder Associations and estates for RSSF assistance with costs of certification. 4.3 Annual reports from RSPO on numbers and outcomes of	Smallholders wish to achieve certification for sustainability. Evidence from RSPO shows strong support from smallholders elsewhere, and enthusiastic uptake of RSSF support once benefits of certification are evident.

	4.3 Aided by RSSF and with continued support from project partners, each smallholder association applies successfully for RSPO-certification.	subsequent applications to become RSPO-certified.	
5. Evidence and lessons learned from project disseminated to policy makers in Ghana and internationally.	5.1 Fact sheets and policy recommendations submitted to Ghanaian government (Ministry of Food and Agriculture; Ministry of Environment, Science, Technology and Innovation) and equivalent ministries in neighbouring countries committed to rapid expansion of oil-palm cultivation. 5.2 Powerpoint presentations to ~ 1000 delegates at each of two annual RSPO Roundtable meetings. 5.3 Ministry of Food and Agriculture in Ghana and equivalents in neighbouring countries discuss with project partners how best to further disseminate project findings and facilitate RSPO certification in other communities in Ghana and other West African countries.	5.1 Fact sheets and policy documents, with records of dissemination to government ministries, universities, environmental NGOs and RSPO Roundtable meetings. 5.2 Roundtable programmes and proceedings; Powerpoint presentations uploaded to RSPO and project websites. 5.3 Minutes and Action Points arising from discussion meetings.	Government agencies in Ghana and neighbouring countries recognize the importance of smallholders for oil-palm production and the value of promoting sustainable cultivation that improves rural livelihoods. CBD reports and Poverty Reduction Strategy Papers of different countries strongly indicate that this is the case.

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)

1.1 Two graduate Darwin Research Fellows (DRFs) recruited to project from partner organizations.

1.2 DRFs visit UK for two periods of six months each, to take MRes modules at University of Leeds.

1.3 DRFs each complete two project dissertations reporting results of BAP field experiments, which contribute successfully to gaining sufficient credits for award of MRes degrees.

2.1 BAP experiment runs for 12 months; smallholders keep monthly records of FFB weights sold to mill and prices paid, and send data to DRFs by mobile phone texts (SMS).

2.2 Smallholder surveys to obtain data on crop management, socio-economic and environmental variables, including constraints on translating additional FFB yields into additional income, with particular focus on constraints imposed on women. Fieldwork to survey birds and insects in smallholdings and forest, and collect soil samples in smallholdings, at start and end of BAP experiment.

2.3 Spatial modelling of key drivers of variation in FFB yields and incomes, and of the robustness and reliability of cost-effective measures to identify HCV forest; analysis of BAP experiment data, including laboratory analysis of soil quality, identification of insects, and verification of bird vocalizations.

3.1 Organize 10 community-based BAP and land-use planning dissemination and training events, each for ~100 smallholders, supported by Handbook of Best Agricultural Practice and with assistance and input from participants in BAP experiment, who will be trained appropriately (i.e. training the trainers).

3.2 Conduct surveys via questionnaires and multiple-choice quizzes to gauge attitudes and levels of knowledge and understanding of BAP, including identification and prioritisation of HCV forest for long-term protection, before and after each knowledge-dissemination and training event.

3.3 Refine dissemination and training material based on feedback from events, and broadcast via means deemed most suitable by smallholders (social media, website, leaflets, pamphlets, posters, videos, etc).

4.1 Organize 10 community-based certification events, each for ~100 smallholders and supported by a Handbook on Achieving RSPO-Certification, giving guidance on forming Smallholder Associations and support networks, and on applying together to RSSF for assistance with costs of certification.

4.2 Monitor RSSF applications and provide feedback and assistance where needed to ensure successful outcomes.

4.3 Organize community visits and use newly-established support networks to assist Smallholder Associations in receipt of RSSF funding to successfully complete process of RSPO certification.

5.1 Meeting with Ministry of Food and Agriculture in Ghana to present fact sheets and policy recommendations arising from project.

5.2 Dissemination of material to other government ministries, universities and environmental NGOs operating in region, including through end of project workshop.

5.3 Presentations to RSPO Roundtable Meetings in 2018 (RT15) and 2019 (RT16).

Annex 2 Report of progress and achievements against final project logframe for the life of the project

Project summary	Measurable Indicators	Progress and Achievements
Impact: Promotion of sustainable agriculture to improve rural livelihoods and protect biodiversity.		The project has delivered clear evidence-based policy guidance, advice and assistance to smallholders, promoting sustainable oil-palm cultivation that boosts smallholders' incomes, supports farmland biodiversity and ensures the long-term protection of high-conservation-value rainforest.
Outcome Improved agricultural practices increase incomes of Ghanaian oil-palm smallholders, boost biodiversity within smallholdings and adjacent forest, promote sustainability certification by smallholders and ensure robust land-use planning to protect high-conservation-value rainforest.	0.1 Oil-palm (fresh fruit bunch) yields of focal smallholders using Best Agricultural Practice increase by 50-100%, from 3-5 tonnes ha^{-1} $year^{-1}$ to 7-10 tonnes ha^{-1} $year^{-1}$, increasing annual household incomes by an average of 5,000-10,000 GHC (£900-1800) by end of Yr2. 0.2 Bird, butterfly, ant and termite biodiversity within smallholdings using Best Agricultural Practice and adjacent forest, including foraging success of focal bird species, increase by >10% in comparison to controls by end of Yr2. 0.3 Evidence-base of economic benefits of Best Agricultural Practice disseminated to >1000 smallholders together with training in applying BAP, including robust and cost-effective identification and prioritisation of HCV forest for long-term protection, resulting in widespread adoption by Yr 3.	0.1 Yields were increased significantly through adoption of Best Agricultural Practice, in particular contouring of soil around palms to reduce rainwater runoff, with the highest yields indicating a potential three-fold increase, from a mean of 5.7 t ha^{-1} yr^{-1} up to 17 t ha^{-1} yr^{-1}. Given the average size of each smallholding (~2 ha) this increase translates into an average additional income of up to ~£1,300 yr^{-1} $household^{-1}$, based on a price of 400 GHC (£57) $tonne^{-1}$ paid for FFBs at the mill gate. 0.2 Across taxa, ~60-80% of those species recorded in high-conservation-value forest were also present in oil palm, compared to only ~15-30% for industrially grown oil palm elsewhere. Adoption of BAPs had little or no discernible effect on the species richness of birds, butterflies or ants within oil palm, indicating that BAP permitted large gains in FFB yield with little or no cost in terms of biodiversity. 0.3 Knowledge of how to apply Best Agricultural Practice and appreciation of its benefits has increased substantially among our focal communities of smallholders (>500 in total), among whom 54% of women and 65% of men surveyed have now adopted BAP. In addition the Ministry of Food and Agriculture in Ghana have established a new programme in BAP, providing ongoing technical support and advice in return for agreement by farmers to maintain BAP within their smallholdings and comply with agreements to protect high conservation value forest. They have set a target of 15,000 smallholders to be registered with this programme by the end of 2019, providing a very effective means for much broader dissemination and uptake of our project findings and advice. 0.4 Our focal communities of smallholders have each formed very effective associations and support networks forming the main route for dissemination

	0.4 More than 500 smallholder farmers adopting BAP achieve RSPO certification, including approval of plans for identifying and conserving HCV forest, by Yr 3.	and exchange of information with our project partner Solidaridad, who are providing ongoing support and assistance to smallholders with RSPO certification. In practice, certification will be obtained by each smallholder association (not individual smallholders) via the new palm oil mill opened by Solidaridad in Assim Foso in 2016. The process of certification is well in hand and on target to be completed by 2020.
Output 1. Two Darwin Research Fellows from project partner organizations trained to design and carry out field experiments and to analyse, interpret and report data obtained.	1.1 DRFs successfully complete MRes modules in advanced statistics and experimental design, quantitative census methods, avian and insect identification and GIS. 1.2 DRFs each write up two reports on data and findings arising from BAP experiment, which are up-loaded onto the RSPO website. 1.3 DRFs are each awarded MRes degrees and co-author a minimum of four peer-reviewed open access publications quantifying the FFB yield, income and biodiversity benefits of improved agricultural practices.	1.1 All modules were completed successfully by both DRFs in the programme of study for MSc by Research. *Evidence provided in Section 3.1 of report and Annexes 7.2, 7.3.* 1.2 Both DRFs completed and submitted an MSc by Research thesis, each with an accompanying summary report (Policy and Practice Briefing) Reports completed and will be uploaded to accompany publication of full findings in international peer-reviewed literature. *Evidence provided in Section 3.1 of report and Annexes 7.4 to 7.7.* 1.3 Both DRFs successfully awarded MSc by Research at University of Leeds. They are first authors of two research papers and co-authors of a further two in preparation for submission to international peer-reviewed journals in summer 2019. *Evidence provided in Section 3.1 of report and Annexes 7.4, 7.5, 7.8, 7.9.*
Activity 1.1. Two graduate Darwin Research Fellows (DRFs) recruited to project from partner organizations.		Achieved at beginning of project Yr1.
Activity 1.2. DRFs visit UK for two periods of six months each, to take MRes modules at University of Leeds.		DFS each visited UK for 15 months in total.
Activity 1.3. DRFs each complete two project dissertations reporting results of BAP field experiments, which contribute successfully to gaining sufficient credits for award of MRes degrees.		Each DRF was awarded an MSc by Research at the University of Leeds, UK
Output 2. Measurement and authentication of increases in Fresh Fruit Bunch yield, income and biodiversity resulting from Best Agricultural Practice, and of the usefulness of easily-obtained	2.1 Monthly records of oil-palm income (quantity of FFBs sold and price from mill) from control (current management) and experimental (Best Agricultural Practice) plots of 40 smallholders in BAP experiment, together with report on socio-	2.1 Monthly records of FFB harvests were obtained from 31 farms, together with data on prices paid by mill, with subsequent report on constraints on realizing income benefits. Project partner Solidaridad have now taken action to greatly mitigate the major constraints and potentially boost incomes further through access to international markets. *Evidence provided in Section 3.2 of report and Annex 7.16.*

measures to identify HCV forest for land-use planning.	economic and logistical constraints on both women and men from realizing income benefits of increased FFB yields. 2.2 Permanent transects established and census data (species richness, abundance and composition) obtained for birds and insects in experimental and control plots of 40 smallholders in BAP experiment and adjacent forest plots. Additional census data on topographical and vegetation characteristics of study plots in forest. Database on foraging behaviour of focal bird species within oil-palm in experimental and control plots. Fully catalogued reference collections with online databases for new species. 2.3 Published data quantifying the FFB yield, income and biodiversity benefits of Best Agricultural Practice for oil-palm smallholders in target communities, and the relationships between topographical and vegetation characteristics of forest and biodiversity.	2.2 Permanent transects have been established with census data obtained for birds and insects at 92 study plots in total, together with data on topographical and vegetation characteristics of study plots in both oil palm and forest and fully catalogued reference collection of ants. *Evidence provided in Section 3.2 of report and Annexes 7.18, 7.19, 7.20. Online databases will be published on open access site (e.g.Dryad) to accompany research publications (Output 1.3 above).* 2.3 Externally evaluated MSc theses plus science-for-policy report to be made freely available at http://www.sensorproject.net/reports/. *Evidence provided in Section 3.1 Output 2 of report and Annexes 7.4, 7.5*.
Activity 2.1. BAP experiment runs for 12 months; smallholders keep monthly records of FFB weights sold to mill and prices paid, and send data to DRFs by mobile phone texts (SMS).		This was achieved with data obtained by employing a member of each smallholder community equipped with suitable measuring equipment, rather than by self-reporting by farmers, thus ensuring that data were independent, quantitative and objective.
Activity 2.2. Smallholder surveys to obtain data on crop management, socio-economic and environmental variables, including constraints on translating additional FFB yields into additional income, with particular focus on constraints imposed on women. Fieldwork to survey birds and		Survey data were obtained for ~100 smallholders and all fieldwork was completed on schedule.

insects in smallholdings and forest, and collect soil samples in smallholdings, at start and end of BAP experiment.		
Activity 2.3. Spatial modelling of key drivers of variation in FFB yields and incomes, and of the robustness and reliability of cost-effective measures to identify HCV forest; analysis of BAP experiment data, including laboratory analysis of soil quality, identification of insects, and verification of bird vocalizations.		All data analysis and modelling was completed on schedule.
Output 3. More than 1000 smallholder farmers, comprising men and women equally, have raised awareness of benefits and better knowledge of how to apply Best Agricultural Practice, including robust land-use planning to identify, prioritise and protect HCV forest.	3.1 Before-and-after surveys of smallholders participating in Best Agricultural Practice experiment show measured increases in scores for importance of and satisfaction with BAP, equally among women and men. 3.2 >1000 smallholders attend knowledge dissemination and training events held within smallholder communities and with smallholder out-growers at oil-palm estates. 3.3 Multiple-choice quizzes completed anonymously by smallholders at start and end of knowledge dissemination and training events show measured increases in average scores, equally among women and men.	3.1 Smallholder surveys indicate 54% of women and 65% of men adopting BAP. *Evidence provided in Section 3.2 of report and Annex 7.21.* 3.2 We achieved effective and meaningful knowledge dissemination and exchange with >500 smallholders through our end-of-project community knowledge-exchange workshops, with additional dissemination targeted at 15,000 smallholders through Ghanaian Ministry of Food and Agriculture. *Evidence provided in Section 3.2 of report and Annex 7.22.* 3.3 Smallholders' responses to questions set at end-of-project community knowledge-exchange workshops, together with smallholder inputs to question-and-answer discussion sessions at workshops and site visits to smallholders adopting BAP all indicated strongly raised awareness of benefits and knowledge of application of BAP. *Evidence provided in Section 3.2 of report.*
Activity 3.1. Organize 10 community-based BAP and land-use planning dissemination and training events, each for ~100 smallholders, supported by Handbook of Best Agricultural Practice and with assistance and input from participants in BAP experiment, who will be trained appropriately (i.e. training the trainers).		After consulting with representatives of smallholder associations (see Output 4 below) we held two large end-of-project events rather than 10 smaller ones, reaching >500 smallholders in total, with each event supported by information sheets on Best Agricultural Practice and Biodiversity.
Activity 3.2. Conduct surveys via questionnaires and multiple-choice quizzes to gauge attitudes and levels of knowledge and understanding of BAP, including identification and prioritisation of HCV forest for long-term		After consultation and with the assistance of smallholder association representatives (see Output 4 below) we used verbal and show-of-hand responses rather than questionnaires and multiple-choice quizzes. This worked well and generated high levels of engagement and discussion.

protection, before and after each knowledge-dissemination and training event.		
Activity 3.3. Refine dissemination and training material based on feedback from events, and broadcast via means deemed most suitable by smallholders (social media, website, leaflets, pamphlets, posters, videos, etc).		After feedback from smallholder associations, refined dissemination and training material was distributed and discussed at end-of-project workshops with digital copies sent to all project partners including Solidaridad and printed copies to the Director of Extension Services at the Ghanaian Ministry of Food and Agriculture.
Output 4. More than 500 smallholder farmers form associations and support networks, receive assistance with costs of certification from RSPO and use this to apply successfully for certification.	4.1 Local smallholder associations and support networks share good practice and knowledge, linked by text messaging networks, social media sites or alternatives as preferred by each community. 4.2 Each smallholder association applies successfully for assistance from RSPO's Smallholders Support Fund (RSSF), assisted by community-based certification events and supported by a handbook on achieving RSPO-certification. 4.3 Aided by RSSF and with continued support from project partners, each smallholder association applies successfully for RSPO-certification.	4.1 Our focal communities of smallholders have each formed oil palm associations and support networks. *Evidence provided in Section 3.2 of report.* 4.2 These networks are forming the main route for dissemination and exchange of information with our project partner Solidaridad, who are providing ongoing support and assistance to smallholders with RSPO certification. *Evidence provided in Section 3.2 of report.* 4.3 In practice, certification will be obtained by each smallholder association (not individual smallholders) via the new palm oil mill opened by Solidaridad in Assim Foso in 2016. This process is in hand and on target to be completed by 2020. *Evidence provided in Section 3.2 of report.*
Activity 4.1. Organize 10 community-based certification events, each for ~100 smallholders and supported by a Handbook on Achieving RSPO-Certification, giving guidance on forming Smallholder Associations and support networks, and on applying together to RSSF for assistance with costs of certification.		This activity was made unnecessary by the fact that our focal smallholder communities had already formed Smallholder Associations with ongoing support and assistance being given to each association by Solidaridad.
Activity 4.2. Monitor RSSF applications and provide feedback and assistance where needed to ensure successful outcomes.		Certification will now be obtained by the new palm oil mill opened by Solidaridad in Assim Foso in 2016 rather than by the smallholders directly. This greatly facilitates certification and helps ensure that both the growing of oil palm and the processing of fruit to produce palm oil adhere to RSPO

		sustainability principles and criteria. The process of mill certification is in hand and on target to be completed by 2020.
Activity 4.3. 3 Organize community visits and use newly-established support networks to assist Smallholder Associations in receipt of RSSF funding to successfully complete process of RSPO certification.		See Activity 4.2 above.
Output 5. Evidence and lessons learned from project disseminated to policy makers in Ghana and internationally.	5.1 Fact sheets and policy recommendations submitted to Ghanaian government (Ministry of Food and Agriculture; Ministry of Environment, Science, Technology and Innovation) and equivalent ministries in neighbouring countries committed to rapid expansion of oil-palm cultivation. 5.2 Powerpoint presentations to ~ 1000 delegates at each of two annual RSPO Roundtable meetings. 5.3 Ministry of Food and Agriculture in Ghana and equivalents in neighbouring countries discuss with project partners how best to further disseminate project findings and facilitate RSPO certification in other communities in Ghana and other West African countries.	5.1 Policy briefs on impacts of BAP on fruit yields and biodiversity were submitted to and discussed with the Director of Extension Services at the Ghanaian Ministry of Food and Agriculture, the Ghanaian Wildlife Service and CBD points of contact in Ghana. *Evidence provided in Section 3.2 of report and Annexes 7.6, 7.6.* 5.2 Powerpoint presentations in addition to information booth and representation at dedicated conference session at RSPO Roundtable meetings. *Evidence provided in Section 3.2 of report.* 5.3 Further dissemination of project findings was discussed at an end-of-project impact workshop attended by multiple diverse stakeholders. *Evidence provided in Section 3.2 of report.*
Activity 5.1. Meeting with Ministry of Food and Agriculture in Ghana to present fact sheets and policy recommendations arising from project.		Achieved at our end-of-project community knowledge-exchange workshops and impact workshop, attended by staff from the Ministry.
Activity 5.2. Dissemination of material to other government ministries, universities and environmental NGOs operating in region, including through end of project workshop.		Material disseminated to multiple GOs and NGOs, including at end-of-project impact workshop.
Activity 5.3. Presentations to RSPO Roundtable Meetings in 2018 (RT15) and 2019 (RT16).		Achieved in 2017 and 2018.

Annex 3 Standard Measures

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
Training Measures							
1a	Number of people to submit PhD thesis						
1b	Number of PhD qualifications obtained						
2	Number of Masters qualifications obtained	2	Ghanaian	One female, one male	Impacts of Best Agricultural Practice on smallholder farmers' oil palm fruit yields, income and biodiversity	English	One thesis focused on fruit yields and income, the other on biodiversity
3	Number of other qualifications obtained						
4a	Number of undergraduate students receiving training	3	British	Three female	Impacts of BAP on species composition and functional diversity	English	Research projects analysing project data, all completed to high standard
4b	Number of training weeks provided to undergraduate students	18	British	Three female	Impacts of BAP on species composition and functional diversity	English	15hrs per week for 12 weeks each

4c	Number of postgraduate students receiving training (not 1-3 above)						
4d	Number of training weeks for postgraduate students						
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification (e.g., not categories 1-4 above)						
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)						
6b	Number of training weeks not leading to formal qualification						
7	Number of types of training materials produced for use by host country(s) (describe training materials)	2					Information sheets on adopting BAP and supporting biodiversity in oil palm

Research Measures		**Total**	**Nationality**	**Gender**	**Title**	**Language**	**Comments/ Weblink if available**
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)						
10	Number of formal documents produced to assist work related to species identification, classification and recording.						
11a	Number of papers published or accepted for publication in peer reviewed journals						Four in preparation for submission in 2019

11b	Number of papers published or accepted for publication elsewhere						
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	4					Databases for birds, ants, butterflies and moths
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country						
13a	Number of species reference collections established and handed over to host country(s)	1					Fully-catalogued reference collection of ants
13b	Number of species reference collections enhanced and handed over to host country(s)						

Dissemination Measures		**Total**	**Nationality**	**Gender**	**Theme**	**Language**	**Comments**
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	3					
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	8					Listed in Output 5 above

Physical Measures		**Total**	**Comments**
20	Estimated value (£s) of physical assets handed over to host country(s)		

Physical Measures		Total	Comments
21	Number of permanent educational, training, research facilities or organisation established		
22	Number of permanent field plots established	92	80 study plots within oil palm, 12 in HCV forest

Financial Measures		Total	Nationality	Gender	Theme	Language	Comments
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work	**185,163**					Details in Section 8.2

Annex 4 Aichi Targets

	Aichi Target	Tick if applicable to your project
1	People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	✓
2	Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	✓
3	Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	
4	Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	
5	The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	
6	All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	
7	Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	
8	Pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	
9	Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	
10	The multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	
11	At least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	
12	The extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	
13	The genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	

14	Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	
15	Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	
16	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	
17	Each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	
18	The traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	
19	Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	✓
20	The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	

Annex 5 Publications

Type * (e.g. journals, manual, CDs)	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. web link, contact address etc)
MSc by Research thesis	Factors that influence yields in oil palm smallholdings in Ghana	Ghanaian	British	Female	University of Leeds	https://library.leeds.ac.uk/info/1104/theses
MSc by Research thesis	Explaining patterns in biodiversity on smallholder oil palm farms in Ghana	Ghanaian	British	Male	University of Leeds	https://library.leeds.ac.uk/info/1104/theses

Annex 6 Darwin Contacts

Ref No	3108
Project Title	Promoting biodiversity in sustainable oil-palm landscapes for West African smallholders
Project Leader Details	
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Role within Darwin Project	Project management and co-ordination in Ghana
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Partner 2	
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Partner 3	
Name	Dr Winston Asante
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Role within Darwin Project	Expertise in BAP and land-use planning
Address	
Fax/Skype	
Email	
Partner 4	
Name	Rosemary Addico
Organisation	Solidaridad West Africa

Role within Darwin Project	Advice and assistance with outreach and extension activities
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