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USAID GREENING PREY LANG

CONSERVATION WELLBEING IMPACTS IN THE PREY LANG EXTENDED LANDSCAPE

IMPACT ASSESSMENT REPORT

January 2022

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Cover Photo: An IBIS Rice farmer holding bunch of paddy rice. Credit: Sansom Mlup Prey (SMP).

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ACRONYMS

BNS	Basic necessity survey
CI	Credible interval
MoE	Ministry of Environment
MFI	Microfinance institution
PA	Protected area
PES	Payments for environmental services
PLEL	Prey Lang Extended Landscape
WCS	Wildlife Conservation Societ

EXECUTIVE SUMMARY

Since 2002, the Wildlife Conservation society (WCS) has provided technical and financial assistance to the Royal Government of Cambodia and local community groups to manage two protected areas (PAs) in the Northern Plains landscape, part of the wider Prey Lang Extended Landscape (PLEL) in northern Cambodia. Management of the two protected areas has evolved over time and can largely be divided into two main areas: more traditional protected area management activities, such as ranger patrols and biodiversity management, and the provision of three payment for environmental services (PES) interventions.

The overall aim of this evaluation was to quantify the human wellbeing impacts of the PAs and PES interventions, notably an agri-environmental incentive programmes known as IBIS Rice, in the Northern Plains landscape. This report focuses on the following research questions:

1. Have PAs in the PLEL had positive or negative impacts on human wellbeing?
2. Has the IBIS Rice programme delivered additional benefits to human wellbeing in the PLEL?

The evaluation built upon on the long-term research programme into the environmental and social impacts of PAs and PES interventions in the Northern Plains landscape that was initiated in 2008 and subsequently continued every three years (2011, 2014, 2017). For this round of the assessment, a household survey was conducted with 1245 households in 15 villages located within the two PAs and five matched control villages. Changes in three key indicators of household wellbeing (economic status as measured by the Basic Necessity Survey (BNS) score, total rice harvest and food security) were assessed by comparing similar matched households living inside and outside the two protected areas for PA impact assessment and participant and non-participant households for the IBIS Rice impact assessment.

The evaluation findings showed that management of the two protected areas has not disadvantaged within-PA households, who have steadily improved their economic status with each round of the evaluation since 2008. However, it was also found that households living in the five control villages, for whom the average economic BNS score decreased between 2014 and 2017, improved their economic status at a faster rate than within-PA households for the latest evaluation period (2017 to 2021). No significant differences were found between within-PA and non-PA households for total rice harvest or household food security, although the average value of both indicators fell for the first time since 2008.

For the IBIS Rice programme, the evaluation showed that the programme continues to benefit participant farmers. Over the latest evaluation period, from 2017 to 2021, the average annual earnings of surveyed participant farmers increased by 98% and the average number of years in which participants received benefits between surveys rose from 1.9 to 2.4 years. No effects were found total rice harvest or household food security.

Key recommendations made in 2020, following the previous evaluation round in 2017, were assessed and updated:

i) Develop ways to integrate poorer farmers into the IBIS Rice programme

Poor farmers often have insufficient land to produce a surplus of rice and are therefore effectively excluded from the benefits offered by IBIS Rice. Consequently, identifying routes though which participation in the IBIS Rice programme may be increased among poorer farmers is important for avoiding exacerbating existing wealth inequalities, increasing programme legitimacy within communities and maximising potential for improving household wellbeing, as well as increasing farmer take up. Modest progress was made towards this target between 2017 and 2021, with the proportion

of households that failed to produce a surplus but also participated in IBIS Rice increasing from 3.5% to 7.0%.

ii) Increase farmer uptake of the programme in existing villages

In 2017, although IBIS Rice was found to reduce clearance among participating farmers, minimal effects were observed in total deforestation rates surrounding participating villages. It was therefore recommended that the programme focus efforts on increasing participation within existing villages. However, recent participation data shows that progress towards increasing participation in these villages has stalled and, in some cases, reversed. It remains crucial to meeting the long-term goals of the programme to invest in farmer recruitment, focussing on three main groups: i) former participants who have left the scheme, ii) farmers that produce a surplus but have never participated, and iii) farmers previously found to be non-compliant.

iii) Adopt an iterative approach to adaptive management that incorporates randomised control trials to incrementally increase effectiveness.

It was also recommended that the programme adopt a new approach to adaptive management to test potential improvements to the existing IBIS Rice model. Such efforts should focus on increasing participation among farmers and maximising behaviour change of participants. An iterative process of randomised A/B trials that test potential improvements against the current model offers a robust route for adopting such an approach. It is strongly recommended that such an approach be adopted to assess alternatives to boost recruitment for the 2022 growing season.

In addition to the three recommendations made in 2020, a final recommendation was made to review the evaluation design prior to the next survey round:

iv) Conduct review of social monitoring design

The Northern Plains wellbeing assessment is one of the longest running evaluations of conservation programmes in existence and has enabled WCS to continually assess the impact of its programmes over the past 12 years. However, issues are beginning to emerge related to the BNS indicator of household economic status and the aging nature of the household panel. It is recommended that a review of these issues be conducted prior to the next survey round to ensure the continued utility of the evaluation design.

1. INTRODUCTION

Since 2002, the Wildlife Conservation society (WCS) has provided technical and financial assistance to the Royal Government of Cambodia (RGC) and local community groups to manage protected areas (PAs) in the Northern Plains landscape in northern Cambodia. This landscape is one of the largest remaining complexes of the mixed deciduous dipterocarp and lowland evergreen forests that once covered much of mainland Southeast Asia (Fig. 1). Within this landscape, the conservation models supported by WCS have focussed on three protected areas: Kulen Promtep (established 1993), Chhep (established 2002) and Prey Preah Rokha (established 2016) Wildlife Sanctuaries. Prior to 2005, these PAs received little active management but are now managed at provincial level by the Provincial Department for Environment following the decentralisation of protected area management in 2016. Wider conservation policy is set at national level by the General Department of Administration of Conservation and Protection within the Ministry of Environment (MoE). In 2019, management of the Northern Plains landscape was integrated into the wider Prey Lang Extended Landscape (PLEL) as part of the Greening Prey Lang project supported by USAID.

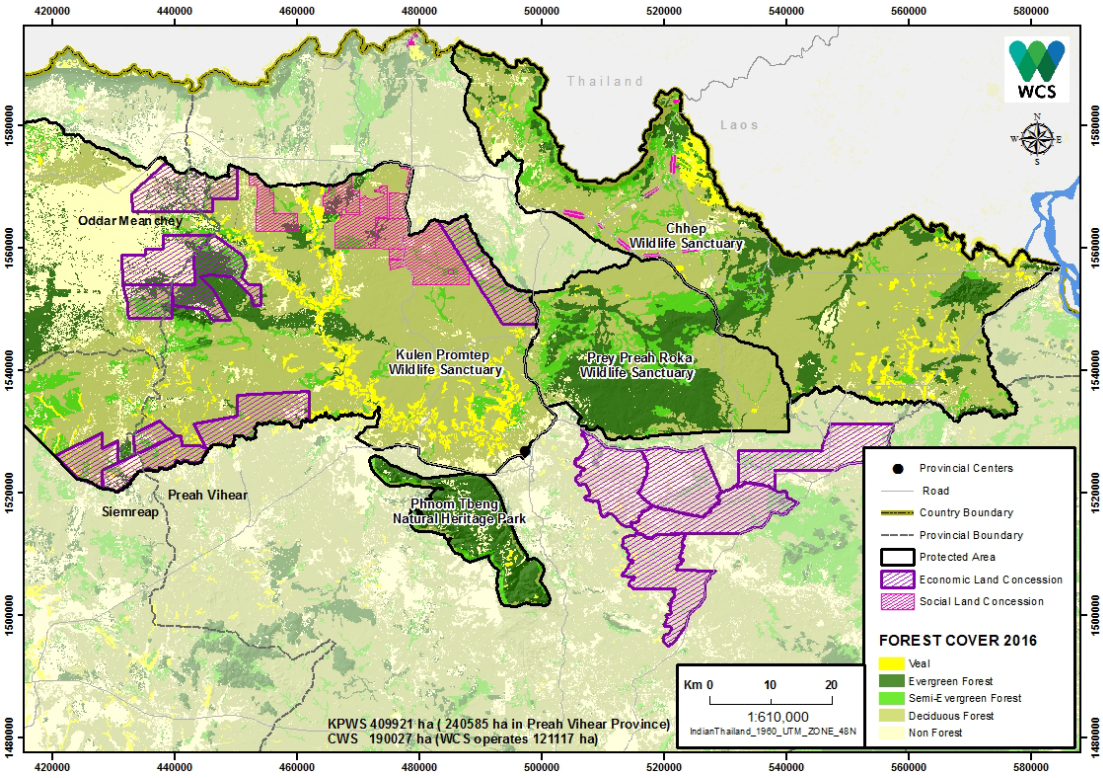

Figure 1: Map of protected areas receiving support from WCS within the Northern Plains landscape (source: WCS).

As part of WCS's overall commitment to continued learning and improvement of management practices within the Northern Plains landscape, a long-term evaluation of programme outcomes has been conducted since 2008. This evaluation has included a triennial survey of a panel of households living in villages within and outside the PAs located within the landscape. This evaluation programme has enabled WCS to regularly assess the impacts of programme activities on household wellbeing. The purpose of this report is to document the findings of the latest survey round conducted in 2021. This analysis builds on prior studies conducted by Clements *et al.* (2014, which covered 2008-2011), Beauchamp *et al.* (2018a; which covered 2014) and Clements et al. (2020; which covered 2017). The purpose of the 2021 evaluation was to assess the social impacts of PAs and an agri-environmental incentive programme known as IBIS Rice for households in the PLEL.

The main research questions of the study were:

1. Have PAs in the PLEL had positive or negative impacts on human wellbeing?
2. Has the IBIS Rice programme delivered additional benefits to human wellbeing in the PLEL?

2. BACKGROUND

2.1. PROGRAMME ACTIVITIES

The evaluation focuses on Kulen Promtep and Chhep Wildlife Sanctuaries only as no villages are located inside Prey Preah Rokha Wildlife Sanctuary. The two PAs are located in remote forest areas and the core areas contain 19 long-established villages that had 1,820 households in 2005. At that time, local people were primarily subsistence farmers, practicing either rain-fed paddy rice or shifting cultivation and were dependent on forest resources as a safety net and for cash income, particularly from the sale of resins from dipterocarp trees. Since then, there has been significant growth in the production of cash crops, such as cashew and cassava, in many upland areas of Cambodia (Travers *et al.* 2015) and a concurrent decline in the importance of resin collection. This has been assisted by improvements in road infrastructure that has seen access become significantly easier for many of the villages inside the PAs (Beauchamp *et al.* 2018b).

Under Cambodian law, local uses of natural resources within PAs are legal, although forest clearance, commercial logging, and hunting or trade in threatened species are illegal. Villages were permitted by PA authorities to expand agriculture to a limited extent within agreed land-use plans. Under the 2008 Protected Area law, which determines the governance of PAs and management responsibilities of MoE, PAs should be zoned into distinct areas within which different levels of natural resource use are permitted. However, these zones, which have been agreed for the Northern Plains PAs at provincial level, have yet to have agreed management plans. As a result, most farmers do not hold private title over their land, but instead have local approval to claim individual land parcels from village, commune or district officials. This has not stopped land within the PAs becoming increasingly commercialised, further increasing the pressure on intact forest.

Management of the two protected areas has evolved over time (Fig 2.) and can largely be divided into two main areas: more traditional protected area management activities, such as ranger patrols and biodiversity management, and the provision of three payment for environmental services (PES) interventions. The three PES interventions were designed to complement PA management by providing incentives for local communities living within the two PAs to engage in conservation (Clements *et al.* 2010) and consist of direct payments to incentivise the protection of nests of globally threatened birds, a community-managed ecotourism intervention which provides conditional support if villagers engage in bird and habitat protection, and an agri-environmental intervention, known as IBIS Rice, which provides a premium on rice sales for households that abide by community land-use plans. The bird nest protection intervention started in 2005, and by 2016 was operating in all within-PA villages. The ecotourism intervention was originally piloted in one village and was then scaled up in that village and expanded to cover three villages inside the PAs from 2008 onwards.

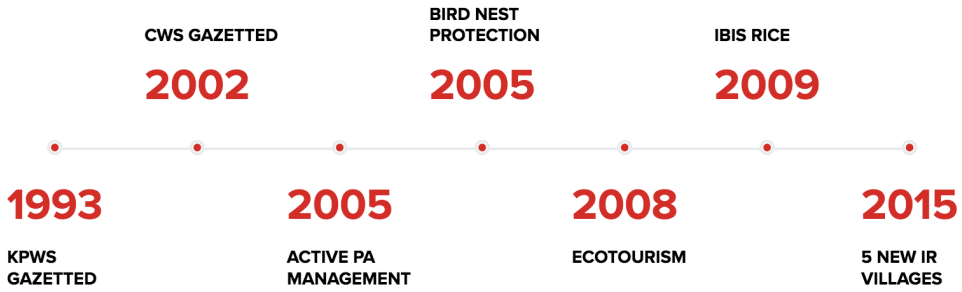

Figure 2: Timeline of key interventions in the Northern Plains landscape.

2.2. IBIS RICE

Following recent expansion, IBIS Rice is now the most significant of the three PES interventions. This intervention was initiated by WCS in 2008 in two villages as a means of generating incentives for individual households to reduce forest and wetlands clearance and hunting of protected species, by benefiting local people. Crucially, these incentives are created by increasing the profitability of rice production, the principal livelihood activity of smallholder farmers. Since 2008, the programme has been expanded to cover 11 villages inside the two PAs. Participation is voluntary, with all households inside participating villages eligible to participate provided they have not previously been found to have broken PA rules. Each participating household signs a conservation agreement in which all of the household's land parcels under cultivation are mapped and the household commits not to expand these parcels or clear additional areas of forest. Compliant households are guaranteed a minimum price for production of Phka Romdoul (a local variant of jasmine rice) provided certain quality standards, including those required for Organic certification, are met. This provides certainty to producers and a 45-65% premium above market prices on the sale of their rice.

As the IBIS Rice programme is designed to provide positive incentives to farmers to reduce hunting and forest clearance behaviours, the initial challenge was to define what land farmers can use, and where the forest boundary starts. In each participating village, the PA managers and WCS worked with local authorities and farmers to develop village land use plans, through a participatory process over a period of two or three years. These land-use plans established forest management zones and clarified ownership over land and natural resources. Each land use plan was approved by the relevant government authorities and is managed by an elected village committee. It specifically sets out which areas can be used for agriculture and residential land, including expansion into areas that are currently forest. Only households who are compliant with the land use plans benefit from IBIS Rice.

IBIS Rice is led by the IBIS Rice Conservation Company, a limited company owned by WCS that is responsible for the purchasing and sale of IBIS Rice. A local NGO partner, also established by WCS, called Sansom Mlup Prey, works with the farmers, providing extension services and liaising over the purchase of the rice. At the village level, management committees of local farmer associations known as Village Marketing Networks were engaged to promote the programme, ensure that farmers understood the conditions of participation and inform the compliance monitoring process.

2.3. PREVIOUS EVALUATION FINDINGS

Three phases of the impact evaluation had been completed prior to the evaluation. The first, in 2008-2011, investigated changes in the social and environmental outcomes that could be attributed to the PA and PES interventions, in comparison with appropriate counterfactuals (Clements *et al.* 2010; Clements *et al.* 2013; Clements *et al.* 2014; Clements and Milner-Gulland 2015). The second, in 2011-2014, continued the same methods, and also used qualitative methods to assess changes in perceived human well-being (Beauchamp *et al.* 2018a; Beauchamp *et al.* 2018b). The final phase, conducted as part of a wider evaluation of the social and environmental outcomes of the Northern Plains programme, was able to advance the analysis methods used due to increases in the number of

households included in each survey round and repeated sampling over time. This allowed for direct attribution of differences observed between households living inside and outside the two PAs and that participated or did not participate in IBIS Rice (Clements *et al.* 2020).

Previous studies conducted by Clements *et al.* (2014), Clements and Milner-Gulland (2015) and Beauchamp *et al.* (2018) provided initial evidence that household economic wellbeing was higher inside the PAs of the Northern Plains landscape than in similar control villages during both the baseline survey in 2008 and two subsequent surveys up to 2014. Over this period, the average economic wellbeing of surveyed households (both inside and outside the PAs) increased significantly. However, Beauchamp *et al.* (2018b) found that the economic wellbeing of households living outside the PAs increased at a faster rate than household living inside the PA between 2008 and 2014. Households inside the PAs were found to have greater rice production but were similarly food secure as households outside the PAs over the same period. Participants in IBIS Rice improved their economic wellbeing at a faster rate than non-participating households. The findings of the 2017 survey round showed that households living inside the PAs improved their economic wellbeing faster than similar households living outside the PAs (Clements *et al.* 2020). As a result of the methodological advances, this improvement could be attributed to living inside the PAs. Similarly, it was shown for the first time that participation in IBIS Rice improved household wellbeing.

3. METHODS

3.1. EVALUATION DESIGN AND IMPLEMENTATION

The evaluation built upon on the long-term research programme into the environmental and social impacts of PAs and PES that was initiated in 2008. The design was based upon WCS's experience in the study landscape from 2002 onwards, and a qualitative research phase that investigated the livelihood strategies and perceptions of local communities. This was used to design social assessment methodologies that would capture the salient aspects of local livelihoods and livelihood changes driven by internal and external factors. Examples include reliance upon sale of liquid resins for cash, the transition to semi-mechanised farming and diversification to cash crops. Between 2005 and 2008, landscape-level surveys were used to map villages, markets, roads and deforestation trends. These variables were used to select matched controls for the intervention villages. Without this prior research, the launch of the impact evaluation programme would not have been possible.

The evaluation applies a quasi-experimental panel survey design, using three primary indicators to assess human well-being outcomes:

1. The Basic Necessities Survey (BNS; Davies and Smith 1998), which incorporates multiple aspects of poverty into a single score for each household in the sample, relative to a locally-derived definition;
2. Annual data on rice harvests, the Cambodian staple food crop;
3. Household food security, measured as the difference between a household's annual rice harvest and its total rice needs for the year.

The latest survey round was undertaken between January and February 2021 across 20 villages. Prior to the implementation of the survey, enumerators were trained in the survey instruments and data collection protocols. All enumerators had worked on similar previous surveys. Participant households were interviewed using a standardised questionnaire (see Appendix A1). In each village, the village chief was interviewed using a questionnaire designed to collect village level data (see Appendix A2).

The evaluation was granted research ethics approval from the Wildlife Conservation Society's Institutional Review Board. All data collectors received prior training in ethical concepts for human subject research. Permission for the survey was granted by the Provincial Governor for Preah Vihear.

3.1.1. SAMPLING

The survey was conducted in 15 villages located within the two PAs and five matched control villages (Fig. 3). This included four within-PA villages that were first surveyed in 2017 to ensure that all IBIS Rice villages were covered by the survey. As these villages were not included in the original design, they were only included in the assessment of IBIS Rice impact. The 11 original villages inside the two protected areas were selected on the basis that they were located inside the core management area defined at the start of the conservation programme in 2005. Villages inside the protected areas but outside the core management areas were not included. Potential matches for the within-PA villages were selected from a database of all 211 villages in Preah Vihear province, choosing only those more than 20km from the PA boundaries to minimise spillovers. A total of five matches were selected, which were all villages in similarly remote forest areas within the province, similar to the within-PA sample in 2005 (see Clements *et al.* 2014 for a full description of the methods used).

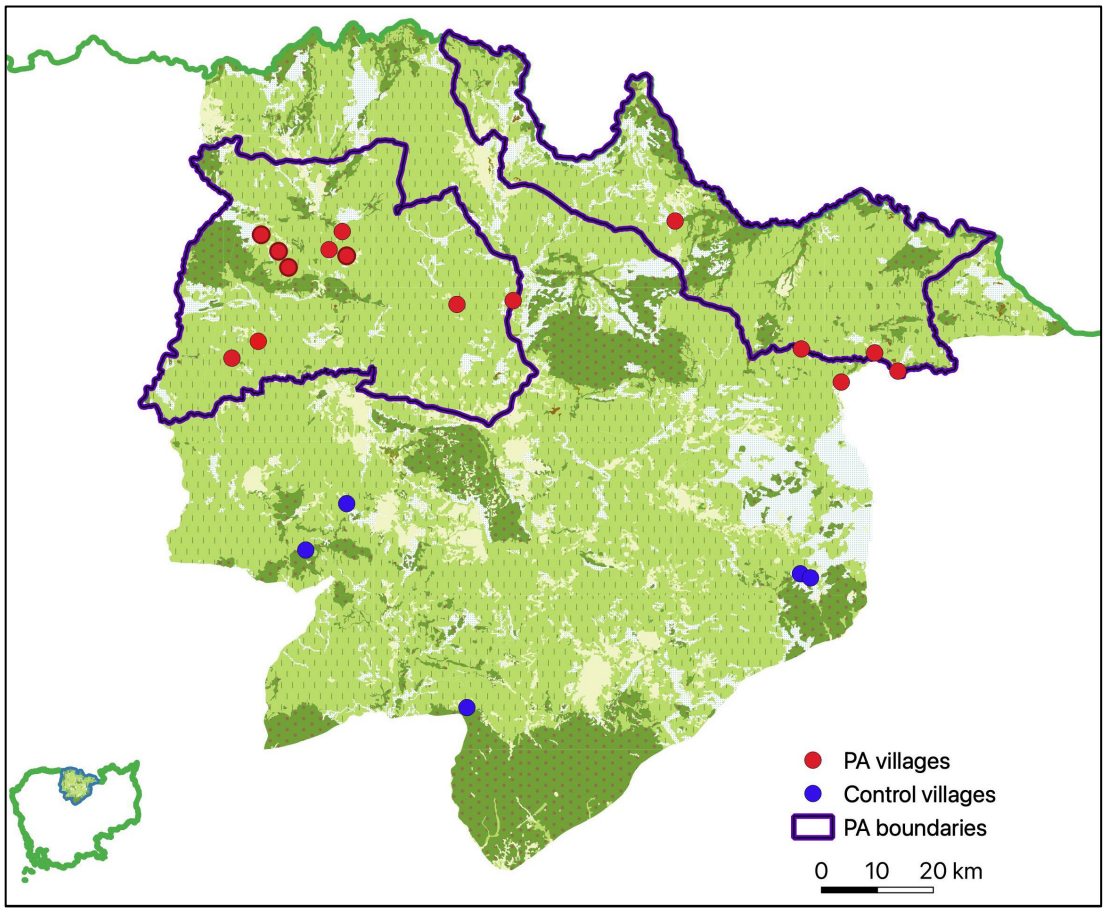

Figure 3: Map of project area, including treatment and control villages.

During the first survey round in 2008, a random sample of households was interviewed in each village. Where possible, the same households have been surveyed during each subsequent survey round. This approach allows for changes in wellbeing to be measured for specific households, thereby enabling more rigorous analysis methods to be used. In addition to the full panel of households interviewed in all five surveys between 2008 and 2021, each survey from 2011 onwards included additional randomly selected replacement households in each of the survey villages.

For the 2021 survey round, 1245 households were interviewed (1013 within-PA households and 232 control households). Significant effort was made to interview all households surveyed in previous survey rounds. As a result, sample attrition (i.e. the number of households that dropped out of the panel) was limited to 75 households from the expanded sample (including replacement households).

Of the 534 households included in the 2008-2011-2014-2017 panel, 31 households were not available for interview at the time of the survey (Fig. 4).

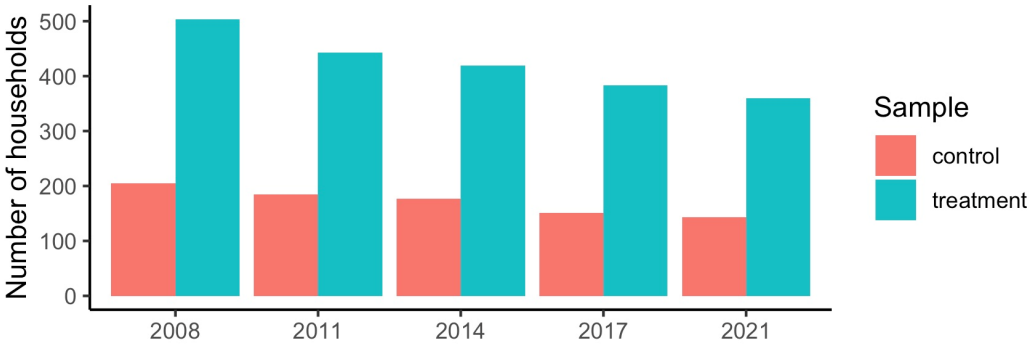

Figure 4: Full PA panel sample size for each survey round.

3.1.2. LIMITATIONS OF DATA COLLECTION AND CHALLENGES FACED

Unlike previous survey rounds, the period between the previous survey in 2017 and the latest survey round was over three years. This was due to delays arising in access to evaluation villages as a result of Covid-19 restrictions. Consequently, survey implementation was delayed by three months. It is possible that this delay may have affected comparisons of wellbeing change between time periods, particularly as the period of the delay included the annual rice harvest, but it is unlikely to have affected the within-period analyses from which the impacts of the two PAs and the IBIS Rice programme are assessed.

3.2. DATA ANALYSIS

3.2.1. TESTED HYPOTHESES

Six hypotheses were tested to assess the impact on wellbeing of PAs and household participation in the IBIS Rice programme, based on the presumptions in the literature of the likely negative effects of PAs (through restrictions on households' activities) and positive effects of IBIS Rice (through provision of benefits). As IBIS Rice is implemented within the two PAs, the effects of this programme are included within the effects of the wider management of the PAs.

Hypothesis WH1: PAs decrease household economic status.

Hypothesis WH2: PAs decrease household rice harvests.

Hypothesis WH3: PAs decrease household food security.

Hypothesis WH4: IBIS Rice increases household economic status as measured by the BNS score.

Hypothesis WH5: IBIS Rice increases household rice harvests.

Hypothesis WH6: IBIS Rice increases household food security.

Table 1 gives the key response and predictor variables considered in the wellbeing analyses. All variables follow the specification applied in Clements *et al.* (2015), Beauchamp *et al.* (2018b) and Clements *et al.* (2020).

Table 1: Key response and explanatory variables used in the analysis of household wellbeing. Response variables in grey shading.

Variable	Description	Type
Economic status	Standardised difference in household economic status as measured by the BNS	continuous
Rice harvest	Difference in total annual rice harvest in kg for a household	continuous
Food security	Difference in rice harvest – annual household rice requirement (kg)	continuous
Treatment	Whether a household lives in a village within a PA	binary
IBIS Rice participation	Whether a household participated in the IBIS Rice programme for at least a one year per period	binary
Household size	The number of members of a household (defined as an economically independent unit)	continuous
Dependency ratio	Ratio of household members aged under 14 or over 60 to those aged between 14 and 60	continuous
Female headed	Whether the household head is female (%)	categorical
Education	Years spent in education by household head	continuous
Age	Age of household head	continuous
>1 ha	Whether household owns an area of land greater than 1 ha	binary
Resin-tapper	Whether a household collects liquid resin	binary
Rice farmer	Whether a household farms rice	binary
Cash crop farmer	Whether a household farms cash crops	binary
Rice farmer type	Type of rice cultivation used by household: paddy, shifting, both, none	categorical
Shop	Whether household runs a shop	binary
Employed	Whether at least one household member has salaried employment	binary
Service	Whether at least one household member provides a service, such as rice milling or battery charging	binary
Labour	Whether at least one household member participates in wage labour	binary
Mini-tractor	Whether a household owns a mini-tractor	binary
Cattle	The number of cattle owned by a household	continuous
PC distance	The distance to the provincial capital	continuous
Schooling	The maximum grade offered by schools in a village	categorical

3.2.2. DIFFERENCE-IN-DIFFERENCE MATCHED ANALYSIS

For both the analysis of the impact of PAs and IBIS Rice, the initial samples were unbalanced (i.e. the average treatment and control households were different), with households inside the PAs and IBIS Rice participants having significantly higher BNS scores than households outside the PAs and non-participants respectively. This can cause issues for the analysis, as any changes observed between control and treatment households could be attributed to the unbalance between the samples. For example, better off households are often more likely to be able to increase their wealth faster than poorer households. As better off households are also more likely to participate in IBIS Rice, it would be impossible to say with confidence whether any improvements in the treatment group relative to the control group were a result of participation in IBIS Rice or simply the better starting economic status of households in the treatment group. To overcome this issue, the analysis used household matching, in which households in the treatment group were matched to similar households in the control group. This has the benefit of giving a balanced sample, although it also leads to the loss of households for which no match can be found.

For the analysis of the impact of the two PAs on household wellbeing, households in the 11 original within-PA villages were matched with households from the five control villages. Matching variables were selected on the basis of the tests of difference between the control and treatment groups and included the three wellbeing indicator variables: economic status, rice harvest and food security. Matching was conducted once, based on 2008 values, and balancing tests were carried out to ensure that matching had achieved a balanced sample. This left a matched sample of 200 households (150 in

the treatment group and 70 in the control). Whilst matching removed the majority of imbalance between the two samples, balancing tests showed some minor imbalances remained.

For the analysis of the impact of participation in the IBIS Rice programme on household wellbeing, participant and non-participant households living in the 15 PA villages were matched at the beginning of each period between surveys. In this instance, rather than being restricted to panel households that were interviewed for every survey, any household that was interviewed for two consecutive surveys (i.e. the two surveys spanning each three year time period) was included in the matching process for that period. Households that participated in the IBIS Rice programme were matched with similar households that had not participated in the programme during the relevant time period. This meant that there was a balanced sample for each time period. The matching variables used to select control households varied between periods to ensure the best match. Matching was based on values at the start of each period. BNS scores were calculated using the weighting for the survey round at the end of each period. As different weights were used for each time period, BNS scores were centred and scaled within each period to ensure comparability between periods (Gelman 2008). This gave a sample of eight treatment and eight control households for the period from 2008 to 2011; 174 treatment and 124 control households for 2011 to 2014; 132 treatment and 99 control households for 2014 to 2017; and 160 treatment and 125 control households for 2017 to 2021.

3.2.3. ESTIMATION OF TREATMENT EFFECTS

For all wellbeing hypotheses, treatment effects were estimated by applying a Bayesian multi-level hierarchical linear regression model following Gelman & Hill (2006), including cluster-level predictors. Multi-level regressions were applied because of the nested nature of grouping factors (household nested in village).

$$y_i \sim N\left(X_i B_{j[i]}, \sigma_y^2\right), \text{ for } i = 1, \dots, n$$

$$B_j \sim N(U_j G, \Sigma_B), \text{ for } j = 1, \dots, J$$

Where y_i is the response indicator, X_i is the n x K matrix of predictors, B is the J x K matrix of grid square level coefficients, U is the J x L matrix of cluster level predictors, G is the L x K matrix of coefficients for the cluster level regression, n is the number of households, J is the number of groups, K is the number of individual-level predictors and L is the number of group-level predictors.

Models were analysed using the rstan package (version 2.21.2; Stan Development Team 2021) in R (version 4.1.0; R Core Team 2021). Where appropriate an uninformative LKJ prior (shape factor = 1) was assigned to the covariance matrix. Adequate convergence was indicated by taking Gelman-Rubin statistics with values <=1.01 and visual inspection of traceplots. Four chains were analysed in parallel, with the number of burn-in iterations set to achieve time convergence. Credible intervals for probability estimates at the 95% level were found by calculating the probability distribution of each response state using the estimated parameter values for each post-warm up run. Continuous variables were centred and scaled by dividing by twice the standard deviation (Gelman 2008). This included the response variables for household rice harvest and food security, as these variables had different scales to other variables, which can affect the efficiency of the MCMC algorithms used. Contemporaneous values of all predictor variables were used throughout.

4. QUANTITATIVE WELLBEING ASSESSMENT

4.1. DESCRIPTION OF THE SAMPLE

4.1.1. PA SAMPLE

Before the regression analysis was carried out, basic descriptive statistics for key socio-economic and demographic variables were calculated for each survey year for the full unmatched PA panel (Table 2).

Table 2: Mean values of key response and explanatory variables for each survey year (N=503).

Variable	2008	2011	2014	2017	2021
Economic status	10.6	11.6	12.6	13.5	15.3
Rice harvest	1779	2591	3287	4021	3047
Food security	-310	1393	1492	2914	2094
Household size	6.0	6.1	6.0	5.9	5.4
Dependency ratio	1.1	1.0	1.0	0.8	0.7
Female headed	6.2%	5.2%	9.3%	10.5%	9.7%
Education	2.3	2.3	2.4	2.4	1.8
Age	40.4	42.5	44.4	45.8	48.5
>1 ha	71.6%	84.3%	90.3%	93.8%	96.6%
Resin-tapper	51.1%	56.5%	47.3%	29.8%	14.9%
Cash crop farmer	8.3%	4.6%	15.3%	48.5%	61.6%
Chamkar farmer	38.6%	29.6%	17.7%	14.7%	12.5%
Number of cattle	4.7	4.0	4.3	5.0	4.5
Shop	14.5%	8.7%	7.6%	7.0%	6.0%
Employed	6.2%	7.6%	13.3%	10.5%	8.0%
Service	2.2%	26.8%	40.8%	30.2%	20.7%
Labour	2.2%	37.0%	49.9%	50.9%	53.1%
Mini-tractor	30.0%	56.1%	76.1%	73.0%	80.7%

These descriptive values demonstrate significant changes in the three main indicators of household wellbeing, as well as other key livelihood variables. The three wellbeing indicators increased for each survey period from 2008 to 2017. This trend continued for economic wellbeing into 2021 but household rice harvest and food security both decreased between 2017 and 2021. Reported areas under cultivation were recorded from 2014 onwards for paddy, upland (*chamkar*) rice and cash crops. This shows that the average reported area under cultivation of both paddy and cash crop cultivation increased each survey round from 2014 to 2021, while the reported area under upland rice cultivation was stable across the same period. This suggests that the drop in rice harvest between 2017 and 2021 was likely to be caused by declining yields rather than conversion of rice fields to cash crops.

The household livelihood variables reveal significant changes in how people support themselves. The collection of liquid resin, previously an important source of cash income for many households, declined from 51% of households in 2008 to just 15% of households in 2021. Similarly, the cultivation of *chamkar* rice declined from 39% of households in 2008 to 13% of households in 2021. This decline is likely to have been driven by increasing mechanisation and conversion of land to the cultivation of cash crops, with mini-tractor (*koyun*) ownership increasing from 30% in 2008 to 81% in 2021 and cash crop cultivation increasing from just 8% of households in 2008 to 62% in 2021.

In addition to the check on the average values of key variables for the full unmatched PA panel, a comparison was also made between households in the treatment and control groups for all survey rounds (Table 3). Univariate tests of difference were used to assess differences between households in the two groups for each time period. This revealed systematic differences between households living inside the two protected areas and those in the five control villages. With respect to the key indicators of household wellbeing (household economic status, rice harvest and food security), households in treatment villages had significantly better economic status than those in the control area in 2011, 2014 and 2017, but not 2008 and 2021. This was mostly an artefact of household economic status showing a decline in control villages between 2014 and 2017 but rebounding in 2021. For the total rice harvest and food security indicators, no significant differences were observed between the two groups in 2021, with both groups showing the decline seen in Table 2. However, this decline was more pronounced for households in the two protected areas.

For the main livelihood variables, although the main trends seen in Table 2 were found for both groups, there were still significant differences in the proportion of households engaged in each livelihood strategy. For example, although resin collection has declined in both groups, significantly more households living inside the two protected areas still engage in this activity than those that live in the five control villages (19% vs 6% respectively). However, shifting rice cultivation was an exception to this trend, with the proportion of household engaged in this activity increasing in 2021 for the control group but continuing to decline for households living in the two protected areas.

Table 3: Household characteristics and livelihood strategies for a panel of 503 households within and outside PAs between 2008 and 2021. Tests of difference applied to compare variable values for households in PA villages against non-PA villages for each year. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

	Control					PA					Test of difference (PA vs. Non-PA)				
	2008	**2011**	**2014**	**2017**	**2021**	**2008**	**2011**	**2014**	**2017**	**2021**	**2008**	**2011**	**2014**	**2017**	**2021**
Households (N)	143	143	143	143	143	360	360	360	360	360					
Household size	6.1	6.3	6.0	6.0	5.6	5.9	6.1	6.0	5.8	5.3	ns	ns	ns	ns	*
Dependency ratio	1.1	1.1	1.2	0.9	0.6	1.1	1.0	1.0	0.8	0.8	ns	.	ns	ns	*
Household head age (yrs)	37.8	40.0	41.6	43.1	46.1	41.4	43.5	45.5	46.9	49.4	**	**	***	***	**
Household head education (yrs)	1.2	1.4	1.6	1.7	1.7	2.7	2.7	2.8	2.6	1.9	***	***	***	***	**
Female headed households (%)	4.9%	4.2%	9.1%	9.1%	8.4%	6.7%	5.6%	9.4%	11.1%	10.3%	ns	ns	ns	ns	ns
Livelihood variables															
Economic status (BNS score)	10.5	11.1	12.0	11.4	15.1	10.7	11.8	12.9	14.3	15.4	ns	*	**	***	ns
Rice harvest (kg)	1346	2454	2859	3848	3278	1950	2645	3457	4089	2955	***	ns	*	ns	ns
Food security (kg)	-648	1208	1313	2694	2268	-175	1466	1563	3001	2025	***	ns	ns	ns	ns
Livelihood strategies															
Resin tapper (%)	31.5%	40.6%	28.0%	20.3%	5.6%	58.9%	62.8%	55.0%	33.6%	18.6%	***	***	***	**	***
>1 ha of paddy fields (%)	64.3%	81.8%	92.3%	92.3%	95.1%	74.4%	85.3%	89.4%	94.4%	97.2%	*	ns	ns	ns	ns
Mini tractor owner (%)	26.6%	37.8%	75.5%	50.3%	81.8%	31.4%	63.3%	76.4%	81.9%	80.3%	ns	***	ns	***	ns
Shifting rice cultivation (%)	44.8%	39.9%	20.3%	18.2%	25.2%	36.1%	25.6%	16.7%	13.3%	7.5%	.	**	ns	ns	***
Cash crop grower (%)	18.9%	10.5%	22.4%	51.0%	65.0%	4.2%	2.2%	12.5%	47.5%	60.3%	***	***	**	ns	ns
Employed (%)	3.5%	3.5%	6.3%	4.2%	3.5%	7.2%	9.2%	16.1%	13.1%	9.7%	ns	*	**	**	*
Service provider (%)	2.1%	30.1%	37.1%	33.6%	16.8%	2.2%	25.6%	42.2%	28.9%	22.2%	ns	ns	ns	ns	ns
Shop owner (%)	14.7%	9.1%	7.0%	7.7%	8.4%	14.4%	8.6%	7.8%	6.7%	5.0%	ns	ns	ns	ns	ns
Labour seller (%)	1.4%	47.6%	60.1%	59.4%	60.8%	2.5%	32.8%	45.8%	47.5%	50.0%	ns	**	**	*	*
Cattle (head)	3.7	4.5	3.7	4.0	3.7	5.2	3.8	4.6	5.4	4.8	***	ns	*	**	*

A comparison of key variables was also made between households interviewed in previous rounds and households that were unavailable for interview in 2021. This comparison found no significant differences between the two groups. However, similar comparisons made for previous survey rounds have found that unavailable households tended to be older, smaller and poorer than those who were available for interview. This suggests that the results of the regression analysis may be vulnerable to slight biases introduced through sample attrition.

4.1.2. PES PANEL

There have been significant changes over time in both the number of full panel households participating in the IBIS Rice programme and the mean earnings of participant households (Table 4). Although participation has plateaued, with a 10% drop in participation between 2018 and 2021, there have been increases over time in both the average number of years that participant households actively participate in the programme and in the amount of money they receive for participation. This suggests that, although the programme is failing to increase take up among panel households, households that do participate are more likely to participate year on year and the financial benefit they derive from this has increased significantly.

Table 4: Summary statistics of household participation in the IBIS Rice programme between 2008 and 2021 (N=360)1.

	2009-2011	2012-2014	2015-2017	2018-2020[2]
IBIS Rice				
No. participants	26	98	99	89
Years participated	1.8	1.8	1.9	2.4
Annual earnings [USD]	883	834	1206	2391

[1] Earnings figures refer to absolute earnings and do not include direct or opportunity costs incurred through participation.

[2] Participation numbers from the 2020-2021 growing season have been left out to aid comparability with other time periods.

A comparison between participant and non-participant households living inside the two protected areas for each time period shows that households that participated in the IBIS Rice programme were significantly better off, grew more rice and were more food secure than non-participant households (Table 5). Comparison of the key livelihood variables also shows significant differences, with participant households more likely to have at least one hectare of land, own a mini-tractor, have more head of cattle and have at least one member of the household in employment. Conversely, participant households were less likely to practice shifting cultivation or have at least one member of the households in wage labour. These are all factors previously associated with household wealth, confirming the idea that IBIS Rice participants are on average better off than non-participants. This confounding association is the reason for employing a matched analysis.

Table 5: Household characteristics and livelihood strategies for participant and non-participant households of the IBIS Rice programme between 2011 and 2021. Tests of difference applied to compare variable values for control and treatment households for each survey year[1]. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

	Control				IBIS Rice participants				Test of difference (IBIS vs. Non-IBIS)			
	2011	2014	2017	2021	2011	2014	2017	2021	2011	2014	2017	2021
Households (N)	416	434	438	705	30	209	222	241				
Household size	5.2	5.8	5.6	5.1	5.4	5.8	5.5	5.2	ns	ns	ns	ns
Dependency ratio	0.8	1.0	0.9	0.8	0.7	0.9	0.9	0.8	ns	ns	ns	ns
Household head age (yrs)	42.2	44.8	45.9	45.1	45.1	45.9	47.2	48.9	ns	ns	ns	***
Household head education (yrs)	3.2	2.2	2.3	1.9	4.0	3.1	2.8	1.9	ns	***	*	ns
Female headed households (%)	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	ns	ns	ns	ns
Livelihood variables												
Economic status (BNS score)	11.5	12.1	13.7	15.2	13.9	14.1	15.4	16.3	**	***	***	***
Rice harvest (kg)	2306	2866	3398	2590	3730	4650	5545	4180	**	***	***	***
Food security (kg)	1232	1314	2325	1735	2693	1983	4517	3290	**	***	***	***
Livelihood strategies												
Resin tapper (%)	56.1%	53.8%	26.0%	18.1%	50.0%	47.8%	42.3%	24.9%	ns	ns	***	.
>1 ha of paddy fields (%)	93.9%	84.1%	90.1%	92.0%	96.7%	98.1%	98.6%	97.1%	ns	***	***	*
Mini tractor owner (%)	60.6%	68.8%	79.7%	78.2%	86.7%	90.0%	88.7%	78.0%	*	***	**	ns
Shifting rice cultivation (%)	1.5%	21.8%	7.1%	2.4%	0.0%	5.3%	2.3%	1.7%	ns	***	*	ns
Cash crop grower (%)	1.5%	12.6%	56.2%	45.2%	6.7%	11.0%	32.4%	38.2%	ns	ns	***	ns
Employed (%)	9.1%	10.0%	7.7%	5.6%	20.0%	20.1%	14.0%	10.0%	ns	**	*	.
Service provider (%)	18.2%	32.6%	21.9%	20.5%	36.7%	44.0%	27.5%	26.1%	.	**	ns	ns
Shop owner (%)	7.6%	5.3%	5.8%	7.7%	16.7%	7.7%	4.1%	5.8%	ns	ns	ns	ns
Labour seller (%)	50.0%	44.1%	53.2%	52.9%	36.7%	41.1%	41.9%	42.3%	ns	ns	ns	*
Cattle (head)	2.9	3.4	4.7	4.5	6.9	6.2	6.7	6.2	**	***	***	**

[1] For each time period, only households living in villages in which the IBIS Rice programme was being implemented have been included in the tests of difference.

4.2. IMPACTS OF PROTECTED AREAS ON WELLBEING

The difference-in-difference matched analysis of the impact of PAs on household wellbeing found that the economic status (BNS score) of households living inside the PAs was not significantly different to similar households in the control group. However, significant differences were found for the periods 2014 to 2017 and 2017 to 2021, with households living inside the two protected areas improving their economic status at a faster rate than the matched control households between 2014 and 2017 and control households improving their economic status at a faster rate than PA households between 2017 and 2021. It is important to view these results in the context of the average household economic status improving for both groups over both time periods. The difference is in the *rate* of improvement.

Table 6: Posterior distribution means and 95% credible intervals from the regression models on the matched dataset (200 HHs) of the effect of protected areas and other predictor variables on the three household wellbeing indicators between 2008 and 2021[1].

	Economic status		**Rice harvest[2]**		**Food security[2]**	
	mean	95% CI	mean	95% CI	mean	95% CI
Intercept	**-9.69**	**(-15.49, -4.06)**	**-0.84**	**(-1.66, -0.02)**	-0.75	(-1.55, 0.04)
Time and treatment						
PA interventions	-0.15	(-1.24, 0.99)	0.06	(-0.10, 0.22)	0.09	(-0.06, 0.24)
2011-2014	-0.26	(-1.38, 0.86)	-0.01	(-0.18, 0.15)	**-0.19**	**(-0.35, -0.03)**
2014-2017	0.83	(-1.87, 3.57)	**0.46**	**(0.07, 0.86)**	0.35	(-0.03, 0.73)
2017-2021	**6.42**	**(3.25, 9.63)**	0.32	(-0.15, 0.78)	0.16	(-0.29, 0.61)
PA * 2011-2014	0.69	(-0.63, 2.01)	-0.01	(-0.21, 0.18)	-0.08	(-0.27, 0.12)
PA * 2014-2017	**2.53**	**(1.17, 3.87)**	0.03	(-0.17, 0.23)	0.03	(-0.17, 0.22)
PA * 2017-2021	**-3.21**	**(-4.66, -1.76)**	-0.01	(-0.22, 0.21)	-0.06	(-0.27, 0.14)
Household variables						
Household size	-0.26	(-0.78, 0.27)	-0.02	(-0.10, 0.06)	-0.04	(-0.12, 0.03)
Dependency ratio	0.24	(-0.11, 0.59)	0.00	(-0.06, 0.05)	0.00	(-0.05, 0.05)
Female headed	0.26	(-0.54, 1.04)	-0.07	(-0.19, 0.05)	-0.08	(-0.19, 0.04)
Education	0.09	(-0.03, 0.22)	**0.02**	**(0.00, 0.04)**	**0.02**	**(0.00, 0.04)**
Household age: mature	-0.22	(-0.82, 0.37)	0.01	(-0.08, 0.09)	0.06	(-0.02, 0.15)
Household age: aging	-0.63	(-1.43, 0.17)	-0.08	(-0.20, 0.03)	-0.02	(-0.13, 0.10)
Livelihood variables						
> 1 ha	**2.00**	**(1.23, 2.76)**	0.08	(-0.04, 0.19)	0.09	(-0.02, 0.20)
Resin tapper	-0.07	(-0.62, 0.48)	0.00	(-0.08, 0.08)	0.01	(-0.07, 0.08)
Cash crop farmer	-0.40	(-1.00, 0.19)	**-0.13**	**(-0.22, -0.04)**	**-0.13**	**(-0.22, -0.05)**
Employed	-0.21	(-1.19, 0.76)	-0.13	(-0.27, 0.02)	-0.12	(-0.26, 0.02)
Labour seller	**0.50**	**(0.03, 0.97)**	-0.04	(-0.11, 0.03)	-0.05	(-0.11, 0.02)
Service provider	-0.17	(-0.74, 0.39)	**0.12**	**(0.03, 0.20)**	**0.10**	**(0.02, 0.18)**
Shop owner	0.41	(-0.57, 1.40)	**0.16**	**(0.02, 0.31)**	**0.15**	**(0.00, 0.29)**
Mini-tractor	**1.62**	**(1.08, 2.15)**	0.01	(-0.07, 0.09)	-0.03	(-0.11, 0.05)
Cattle	0.00	(-0.06, 0.06)	**0.00**	**(0.00, 0.01)**	**0.01**	**(0.00, 0.01)**
Rice farmer: shifting	-0.39	(-1.52, 0.73)	**-0.22**	**(-0.39, -0.05)**	**-0.22**	**(-0.39, -0.06)**
Rice type: no rice	1.23	(-0.31, 2.80)	**-0.56**	**(-0.79, -0.33)**	**-0.50**	**(-0.72, -0.28)**
Rice farmer: paddy only	0.08	(-0.56, 0.72)	**-0.21**	**(-0.31, -0.12)**	**-0.19**	**(-0.29, -0.10)**
Village variables						
PC distance	**0.88**	**(0.08, 1.70)**	**0.14**	**(0.03, 0.26)**	**0.13**	**(0.02, 0.24)**
Schooling	0.36	(-0.05, 0.76)	0.02	(-0.04, 0.08)	0.02	(-0.03, 0.08)
N	200		200		200	

[1] Results shown in bold are non-zero at 95% credible intervals.

[2] Both the rice harvest and food security indicators were centred and standardised to two standard deviations prior to analysis (Gelman *et al.* 2008).

This suggests that, across the whole evaluation period from 2008 to 2021, households living in villages inside the two protected areas have neither benefited nor lost out relative to similar households in villages outside the PAs. This is supported by the fact that the average BNS score for within-PA households remained higher than matched non-PA households in 2021 (14.9 vs 14.7 respectively). However, this does not discount the result that within particular time periods both the within-PA and non-PA households have improved their economic status faster than their respective comparison group.

There is no evidence in support of hypotheses WH1.

For rice harvest and food security, there was no difference observed between households living inside the PAs and the matched control group.

There is no evidence in support of hypotheses WH2 or WH3.

4.3. IMPACTS OF PAYMENTS FOR ENVIRONMENTAL SERVICES ON WELLBEING

The difference-in-difference matched analysis was used to correct for sample imbalances in the comparison between IBIS Rice participants and non-participants within each period (Table 7). The effect of participating in the IBIS Rice programme was estimated to increase household economic status by 0.18 standard deviations. To put this into context, this was approximately equivalent to the estimated effect of each additional year of education provided in a village. The (non-significant) negative effect of time is likely to be because of the non-linear nature of the BNS score, which means that it becomes harder to increase the BNS score as people become better off. There were only two significant social-demographic variables with large effect sizes: owning at least one hectare of farming land and household dependency ratio. The positive effect of household dependency ratio on increasing economic status was a little surprising as it suggests that households with higher levels of dependency were able to improve their economic status more than households with fewer dependents.

There is consistent evidence to support hypothesis WH4 that participating in the IBIS Rice programme increased household economic status over the course of the evaluation period.

Participation in the IBIS Rice programme had no effect, either positive or negative, on household rice harvest or food security. This is unsurprising given that the main focus of the intervention is increasing the price at which farmers are able to sell their crops, rather than yield. Larger households were found to have greater harvests. For food security, the result of the regression was marginal.

There is no evidence to support hypotheses WH5 or WH6 that participating in the PES programmes increased household rice harvest or food security.

Table 7: Posterior distribution means and 95% credible intervals from the difference-in-difference regression models on the matched IBIS Rice dataset on household wellbeing between 2008 and 2021[1].

	Economic status[2]		Rice harvest[3]		Food security[3]	
	mean	95% CI	mean	95% CI	mean	95% CI
Intercept	-0.30	(-1.31, 0.72)	-0.20	(-1.10, 0.69)	-0.17	(-1.12, 0.75)
Time and treatment						
IBIS Rice participant	**0.09**	**(0.01, 0.16)**	0.05	(-0.02, 0.12)	0.04	(-0.03, 0.11)
2011-2014	-0.09	(-0.35, 0.17)	0.06	(-0.17, 0.28)	**-0.31**	**(-0.54, -0.08)**
2014-2017	-0.34	(-0.84, 0.12)	0.07	(-0.35, 0.48)	0.14	(-0.28, 0.57)
2017-2021	-0.51	(-1.15, 0.08)	-0.27	(-0.79, 0.24)	-0.36	(-0.88, 0.19)
Household variables						
Household size	0.01	(-0.07, 0.09)	**0.09**	**(0.02, 0.16)**	0.00	(-0.07, 0.07)
Dependency ratio	**0.06**	**(0.00, 0.11)**	-0.02	(-0.06, 0.03)	-0.02	(-0.07, 0.03)
Female headed	-0.08	(-0.20, 0.05)	0.07	(-0.04, 0.18)	0.04	(-0.07, 0.15)
Education	0.00	(-0.01, 0.02)	0.00	(-0.01, 0.02)	0.00	(-0.02, 0.01)
Household age: mature	0.01	(-0.08, 0.11)	-0.01	(-0.10, 0.08)	0.01	(-0.08, 0.10)
Household age: aging	-0.01	(-0.12, 0.10)	-0.06	(-0.16, 0.04)	-0.06	(-0.16, 0.03)
Livelihood variables						
> 1 ha	**0.44**	**(0.22, 0.66)**	0.07	(-0.14, 0.27)	0.06	(-0.15, 0.27)
Resin tapper	0.02	(-0.06, 0.10)	-0.03	(-0.10, 0.04)	-0.04	(-0.11, 0.03)
Cash crop farmer	-0.02	(-0.10, 0.06)	-0.03	(-0.11, 0.04)	-0.05	(-0.13, 0.03)
Employed	-0.02	(-0.14, 0.09)	0.04	(-0.07, 0.14)	0.05	(-0.06, 0.15)
Labour seller	-0.02	(-0.09, 0.05)	-0.02	(-0.08, 0.05)	0.00	(-0.07, 0.06)
Service provider	-0.03	(-0.11, 0.04)	**0.12**	**(0.05, 0.19)**	**0.07**	**(0.01, 0.14)**
Shop owner	0.02	(-0.12, 0.17)	0.06	(-0.08, 0.19)	0.02	(-0.12, 0.15)
Mini-tractor	0.05	(-0.04, 0.15)	0.08	(-0.01, 0.17)	0.07	(-0.02, 0.15)
Cattle	0.00	(-0.01, 0.00)	0.00	(-0.01, 0.01)	0.00	(-0.01, 0.01)
Rice farmer: shifting	-0.04	(-0.40, 0.32)	-0.02	(-0.34, 0.30)	0.19	(-0.13, 0.51)
Rice type: no rice	-0.08	(-0.42, 0.25)	**-0.44**	**(-0.75, -0.13)**	**-0.39**	**(-0.70, -0.08)**
Rice farmer: paddy only	-0.06	(-0.26, 0.14)	-0.11	(-0.29, 0.07)	-0.02	(-0.20, 0.16)
Village characteristics						
PC distance	-0.09	(-0.24, 0.04)	0.00	(-0.12, 0.12)	0.04	(-0.08, 0.16)
Schooling	**0.08**	**(0.01, 0.15)**	0.02	(-0.03, 0.08)	0.02	(-0.04, 0.07)
N	553		553		553	

[1] Results shown in bold are non-zero at 95% credible intervals.

[2] BNS scores were centred and standardised to two standard deviations across each time period prior to analysis (Gelman *et al.* 2008).

[3] Both the rice harvest and food security indicators were centred and standardised to two standard deviations prior to analysis.

5. QUALITATIVE ASSESSMENT OF WELLBEING

Since 2014, the household survey has included questions relating to more qualitative measures of wellbeing, such as people's sense of security over access to key resources and their ability to participate in decision-making about those resources. As a result, it is possible to make comparisons between within-PA and non-PA households, as well as assessing how these measures have changed over time. The results of this comparison show that, despite long-term improvements in the three key quantitative indicators of household wellbeing used in this assessment, there has been a gradual decline in qualitative wellbeing measures for households living inside and outside the two protected areas (Table 8).

Table 8: Household perceptions of qualitative measures of wellbeing for a panel of 815 households within and outside PAs between 2014 and 2021. Perceptions are scaled from -1 to 1, where negative values imply negative outlooks and positive values imply positive outlooks. Tests of difference applied to compare variable values for control and treatment households for each survey year. Significance values: 'ns' = non-significant; '.' = P <0.1; '*' = P <0.05; '' = P <0.01; '***' = P <0.001.**

	Control			PA			Test of difference (PA vs. Non-PA)		
	2014	2017	2021	2014	2017	2021	2014	2017	2021
Involvement in decision making									
Land management	0.55	0.55	0.26	0.51	0.51	0.29	ns	ns	ns
Forest management	0.52	0.25	0.15	0.51	0.29	0.22	ns	ns	.
Present security of resource access									
Land	-0.14	-0.27	-0.28	-0.21	-0.29	-0.28	ns	ns	ns
NTFPs	0.34	0.09	0.09	0.36	0.01	0.00	ns	ns	*
Resin trees	-0.26	-0.51	-0.37	-0.23	-0.51	-0.30	ns	ns	*
Future security of resource access									
Land	-0.10	-0.33	-0.23	-0.09	-0.38	-0.30	ns	ns	.
NTFPs	0.04	-0.22	-0.27	0.02	-0.29	-0.25	ns	ns	ns
Resin trees	-0.42	-0.61	-0.43	-0.45	-0.61	-0.44	ns	ns	ns
Fairness of resource access									
Land	0.03	-0.30	-0.30	-0.17	-0.41	-0.32	***	*	ns
NTFPs	0.78	0.40	0.44	0.71	0.38	0.44	.	ns	ns
Resin trees	0.08	-0.50	-0.50	0.07	-0.58	-0.49	ns	*	ns
Trust in authorities									
Commune	0.43	0.32	0.25	0.28	0.26	0.21	**	ns	ns
Police	0.31	0.36	0.28	0.13	0.14	0.29	**	***	ns
CPA committee				0.18	0.12	0.00			
Households (N)	179				616				

One of the most striking results from the qualitative measures of household wellbeing is how similar the responses of people living inside the two protected areas were to people in the five control villages. This is despite significant investment in participatory land use planning and law enforcement patrols to address illegal logging (a significant source of resin tree loss) within the two protected areas. There were only two areas in which people inside the protected areas felt better than those outside. These were involvement in decision making regarding forest management and present security of resin trees. However, the differences in perception values in both these areas were small and, for current access to resin trees, it was a case of within-PA perceptions being less negative than the perception of non-PA households.

In general, people only felt positive about two of the broad themes considered: involvement in decision-making and trust in authorities. However, the results for neither of these themes give grounds for confidence in the impact of conservation activities. For involvement in decision-making, the perceptions of both within-PA and non-PA households have significantly declined in positivity since 2014. This is also true for the perceptions of within-PA households towards members of Community Protected Area (CPA) committees - to the point that they are now neither positively nor negatively perceived.

6. HOUSEHOLD DEBT

6.1. CURRENT DEBT LEVELS

In 2021, the household survey was expanded to include a section on household debt. This is an area of increasing concern in Cambodia, where over-indebtedness at the household level is increasingly common due to a boom in loans from microfinance institutions (MFIs, Bylander *et al.* 2018). As 2021 was the first survey round to look at this subject in detail, it was not possible to draw comparisons with previous years to establish trends in household indebtedness within evaluation villages. However, the data collected will form a baseline from which future comparisons can be drawn. At the national level, household debt increased from 12.3% GDP in 2017 to 29.2% in 2020 (CEIC 2021).

Across the 2021 sample, 40% of households reported having outstanding loans. For the average household in debt this translated to 1.04 loans totalling US$1840, of which 76.7% was outstanding. The proportion of households in debt was found to be very similar between within-PA and non-PA households (40% and 39% respectively). However, the value of these loans was significantly different, with the average debt for within-PA households nearly 45% (US$1249) less than for non-PA households (US$1519 and US$2758 respectively). The most common source of these loans, as well as the source of the greatest value of debt (by a ratio of 3:1) was MFIs (Table 9). Despite only a small proportion of households (3.5%) having access to bank loans, the higher value of these loans meant that banks were the source with the second greatest value of debt (US$200,450). The difference in household debt between within-PA and non-PA households can therefore be explained by differences in the rate of access of loans from both banks (3.4% and 4.7%) and MFIs (21.7% and 25.4% respectively), as well as the average value of each loan from MFIs (US$1845 and US$3432 respectively).

Table 9: Source of household debt for the full sample in 2021 (N=1245).

	Proportion of sample with loans	Average loan (US$)	Average amount outstanding (US$)

Savings groups	0.9%	395	353
Rice banks	13.4%	167	167
Private lenders	1.1%	606	313
Resin traders	0.2%	50	50
Relatives/neighbours	13.4%	524	441
MFIs	22.3%	2186	1648
Banks	3.5%	4662	3697

6.2. EFFECTS OF DEBT ON ECONOMIC STATUS

Given the significant difference in debt between within-PA and non-PA households that emerged between the 2017 and 2021 surveys, it was possible that the difference between the two groups over this period in the change in average economic status had been driven by varying access to credit. To investigate this idea further, the PA impact analysis was rerun for the single time period of 2017 to 2021 with an unmatched sample to test for the effect of indebtedness on household economic status (Table 10). This had not been possible for the main analysis detailed in Section 4.2 due to the lack of data on household debt for previous time periods.

Table 10: Posterior distribution means and 95% credible intervals from the difference-in-difference regression models on the unmatched PA panel on household wellbeing between 2017 and 2021[1].

	Economic status	
	mean	95% CI
Intercept	1.91	(-0.34, 4.17)
Time and treatment		
PA interventions	**-2.42**	**(-4.20, -0.74)**
Indebtedness[2]	-0.29	(-0.65, 0.09)
Household variables		
Household size	0.31	(-0.09, 0.73)
Dependency ratio	-0.18	(-0.48, 0.08)
Female headed	-0.57	(-1.21, 0.06)
Education	0.02	(-0.27, 0.30)
Household age: mature	-0.12	(-0.63, 0.36)
Household age: aging	**-0.66**	**(-1.22, -0.14)**
Livelihood variables		
> 1 ha	**1.42**	**(0.32, 2.51)**
Resin tapper	0.03	(-0.53, 0.62)
Cash crop farmer	**0.45**	**(0.05, 0.86)**
Employed	-0.23	(-0.95, 0.46)
Labour seller	0.01	(-0.35, 0.38)
Service provider	-0.20	(-0.64, 0.24)
Shop owner	0.52	(-0.25, 1.28)
Mini-tractor	0.18	(-0.25, 0.61)
Cattle	0.01	(-0.02, 0.04)
Rice farmer: shifting	0.57	(-0.85, 1.91)
Rice type: no rice	-0.01	(-1.62, 1.55)
Rice farmer: paddy only	0.15	(-0.59, 0.91)
N	1160	

[1] Results shown in bold are non-zero at 95% credible intervals.

[2] Indebtedness was centred and standardised to two standard deviations (Gelman *et al.* 2008).

The results of this analysis show that rather than greater levels of indebtedness being associated with increased BNS scores, as would be the case if access to credit was used to fuel improvements in household economic status, increased debt was negatively correlated with changes in BNS score over this time period. Even in the case of the eight households that

had debts of greater than US$15,000 (a level of indebtedness that is significantly greater than average annual incomes in the evaluation villages), the mean BNS score fell. This suggests that households may have either taken out loans to cover losses in economic status or become less well off as a result of over-indebtedness. No difference was found in the relationship between debt and the effect of living inside the two protected areas for this time period.

An alternative explanation for the negative association between household indebtedness and change in BNS may be that loans have been spent on increasing aspects of economic status not covered by the BNS score. Figure 5 shows the varying importance (in terms of total and average value of disbursed loans) of the different reasons given by respondents for taking out a loan.

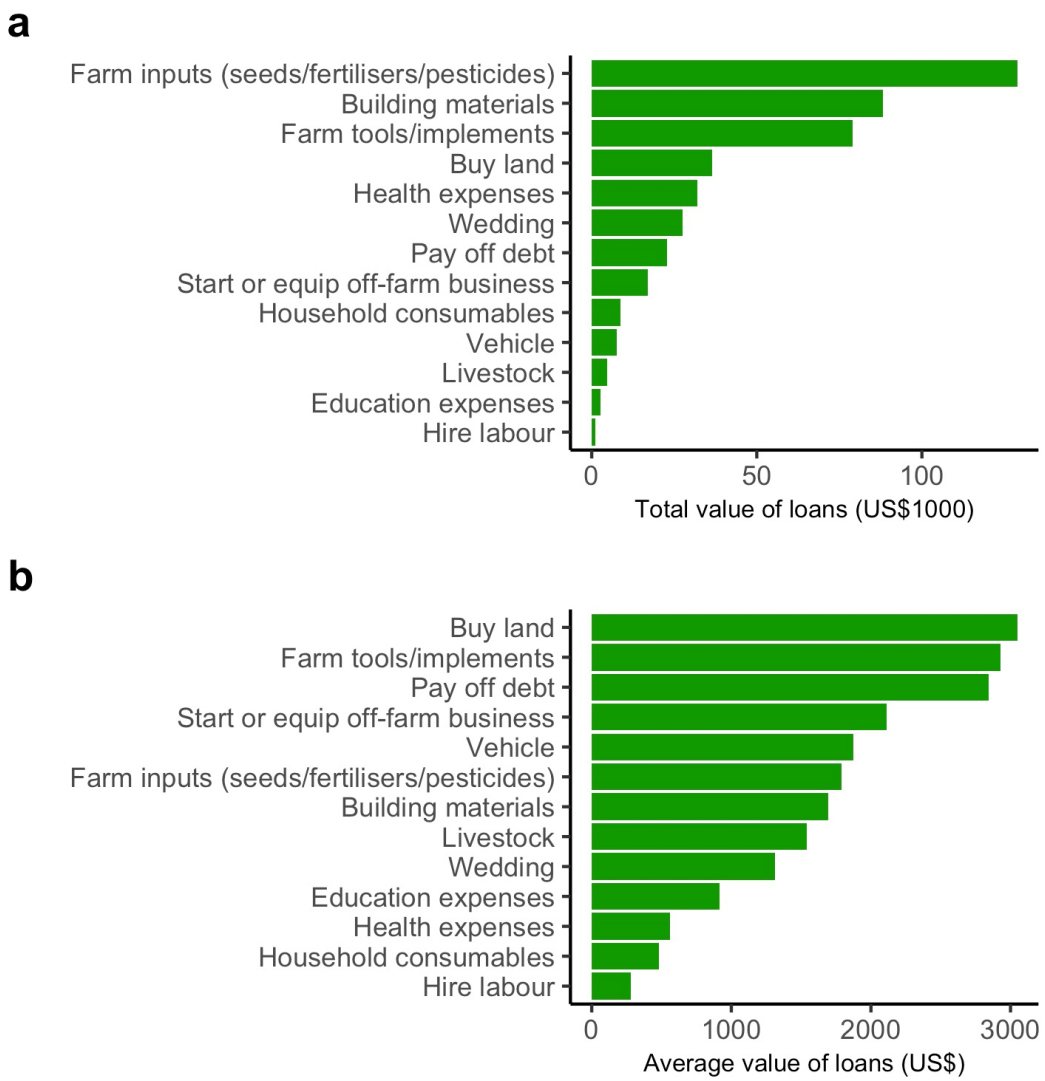

Figure 5: Reasons given for indebtedness ordered by: a) total value; b) average value. Only values shown for respondents who listed a single reason.

This shows that there are a number of diverse reasons why people became indebted. Even though the most important reason with respect to total value of loans taken out was farm consumables, the value of loans is approximately evenly split between paying for material investments and consumables. Although many of the reasons given are to some extent covered by the BNS, it cannot be entirely discounted that BNS scores may have failed to capture the scale of investments for particular items on the list (e.g. building materials).

7. DISCUSSION

7.1. INTERVENTION IMPACTS

7.1.1. PROTECTED AREA INTERVENTIONS

Contrary to the commonly purported narrative that protected areas negatively affect the people living in or around them (Wilkie *et al*. 2006; Brockington & Wilkie 2015), the results of the evaluation found no evidence that households in the treatment area had worse wellbeing outcomes over the course of the full evaluation period compared to households in the control area. However, the overall effect of living inside the two protected areas masks a more volatile picture with respect to the differences between the two groups. For the period from 2014 to 2017, there was strong evidence that treatment households were better off than matched households in the control villages. In fact, for this period, the average economic status of households outside the protected areas actually declined for the first time since 2008. However, this trend reversed for the period from 2017 to 2021, with matched control households significantly outperforming households living inside the two the protected areas (at a time when rice yields declined significantly). Despite significantly greater level of indebtedness in control households over this period, this was found not to have affected the relative difference in improvements of economic status between the two groups. The volatility described is predominantly found in the control group, with the average economic status of households inside the protected areas improving steadily over time. This may suggest that households inside the PAs are more resilient to unfavourable exogenous changes but less able to capitalise when more favourable conditions present themselves. It is also possible that restrictions imposed due to Covid-19 had a more pronounced impact on households inside the protected areas.

The findings also suggest that living inside protected areas has not prevented households from diversifying their livelihood strategies or adapting to new opportunities. This is evidenced by the significant increase in the proportion of treatment households that have moved into cash crop production, providing some form of village service or the supply of labour. These changes have coincided with significant drops in the importance of resin collection and shifting cultivation, which again suggests a move away from more traditional livelihood strategies, a finding that has been replicated in other parts of rural Cambodia (Travers *et al.* 2015). While these findings are encouraging, in that they demonstrate that living inside the PAs has not restricted development opportunities, they also suggest that the interventions being implemented inside the PAs must adapt to changing household priorities, particularly the cultivation of cash crops (such as cashew and cassava) that has seen significant growth over the evaluation period. In the medium- to long-term, this trend is likely to increase pressure on intact forest as the profitability of land increases.

One negative finding of the evaluation is the gradual decline in perceptions of softer qualitative measures of wellbeing across the evaluation villages. This comes despite significant investment in institutional development and efforts to ensure equitable access of resources within the two protected areas. The fact that very few differences were found between within-PA and control households suggests these efforts have not been successful in addressing broader trends within the landscape.

7.1.2. IBIS RICE INTERVENTION

The results of the evaluation of the impact of IBIS Rice on human wellbeing were positive. Following a similar result in 2017, participation in the IBIS Rice programme was found to have improved economic status relative to non-participant households for the second survey round in a row. This is an important result as it reflects the continued material benefit that

participants of the intervention receive in comparison to similar non-participant households. The evaluation findings also show how IBIS Rice farmers are on average participating in more years between surveys and earning significantly more each time they participate. However, 2021 was the first survey round since 2008 for which participation among the original panel of households fell. This may in part be due to the aging nature of this group of households, which is no longer representative of the general population in the evaluation villages. However, it reflects the broader participation data for IBIS Rice, which show farmer numbers either falling or plateaued in all bar one of the villages in which the intervention is currently being implemented. This is a worrying trend as it comes at a time when higher levels of participation are required to generate an impact on forest clearance at the landscape scale (Clements *et al.* 2020).

7.2. CONTINUED UTILITY OF EVALUATION DESIGN

The evaluation described in this report is one of the longest running evaluations of conservation programmes in existence. While this longevity has enabled WCS to continually assess the impact of its programmes over the past 12 years and adapt to new emerging challenges, it does not come without issues. The following section discusses issues that have emerged with the long-term use of the three main wellbeing indicators and panel selection.

7.2.1. WELLBEING INDICATORS

Although the evaluation design makes use of three primary indicators of household wellbeing, the BNS score has been the most useful to date in differentiating the impacts of both the broader PA management interventions and IBIS Rice. In the case of IBIS Rice, the main focus of the intervention is providing financial reward for continued compliance with the conservation agreements made with each participating farmer. However, other aspects of the programme include the provision of high-quality seed and technical guidance to improve productivity. As such, continued use of total rice yields and food security is advised, even if limited impact has been observed for these measures to date.

The BNS was originally selected as an indicator because it is easy to collect, approximates well to a normal distribution (simplifying the analysis), uses participatory methods to populate the list (facilitating communication of results to local communities) and does not suffer from the same volatility as income, which can make longitudinal comparisons challenging. However, as also raised following the previous survey round in 2017, there are concerns that the current list of items used to generate the BNS score is reaching the end of its useful lifetime. As households continue to improve their economic status, the proportion of households that own or have access to each item on the list increases. This is expected and, although there is an issue related to the non-linear increase in economic status required for each marginal increase in BNS score, does not cause significant problems for the analysis until households reach the upper bound of possible scores (i.e. own or have access to every item on the list that contributes to the household score). At this point, it becomes impossible for better off households to improve their scores, thereby skewing the results of the evaluation. In 2021, the highest individual household BNS score was 97% of the maximum possible, suggesting that the next survey round will require a new list or new items to be added to the list. Unfortunately, this makes it impossible to draw comparisons across the whole evaluation period, as is currently done for the analysis of the impact of the two protected areas. An alternative approach is to use the method applied for the IBIS Rice analysis, in which different weightings (and in some cases items) are used for different time periods but where the changes in score are standardised to enable comparability between time periods. However, this approach is still relatively untested and requires greater investigation of its robustness over time.

7.2.2. PANEL ATTRITION AND AGING

In 2008, during the original survey round, a panel of 708 households was randomly selected across 16 villages. Since 2008, this panel has gradually reduced down to 503 households in 2021. While this rate of sample attrition is within expected and acceptable bounds, the loss of sample size reduces the statistical power of the survey to be able to assess the impact of living inside the two protected areas on household wellbeing. Over time, however, the sample has been increased to address this attrition with new and replacement households randomly selected in each village. Although this has increased the power to evaluate the impact of the IBIS Rice programme in particular, it has not fully addressed another issue, which is the gradual departure of the main panel from a representative sample of the general population living in the evaluation villages. In common with the BNS list, the panel is aging and may be reaching the end of its useful lifetime as it moves further and further away from average household characteristics. This has been partly ameliorated by succession within households where aging or dead household heads have been replaced by the next generation within the household. However, as shown in Table 3, the average age of household heads has continued to increase. One relatively straightforward solution to this issue would be adopt a similar approach to that taken for the IBIS Rice analysis and consider separate panels for each time period. This would make use of the refresher samples added over the survey rounds, thereby increasing the sample size and making the sample more representative of the general population.

It is strongly recommended that a review of the evaluation methodology is undertaken prior to the next survey round due in late 2022.

8. RECOMMENDATIONS

Following the previous evaluation in 2017, three recommendations for how to increase programme impact were made in the final report published in early 2020 (Clements *et al.* 2020):

1. Develop ways to integrate poorer households into the IBIS Rice programme.
2. Increase farmer uptake of IBIS Rice.
3. Adopt a new approach to adaptive management.

While action towards these goals has been complicated by Covid-19, it is worthwhile to look back and assess the extent to which progress has been made in each of these three areas.

8.1. DEVELOP WAYS TO INTEGRATE POORER FARMERS INTO PROGRAMME

One of the three recommendations made following the previous survey round was to develop ways to integrate poorer farmers into IBIS Rice. This represents a challenge because poorer farmers tend to produce less rice and be less food secure. Consequently, they are significantly less likely to produce a surplus and will prioritise feeding themselves over selling their own produce and using the proceeds to buy rice produced elsewhere. It is therefore much harder to incorporate them into the programme. Previous estimates of the proportion of households that make up this group have used the area of land each family held when all agricultural land was mapped in 2014. This mapping exercise formed the baseline against which participant family land histories are compared. However, this is now unlikely to reflect households' true land holdings. As such, it is likely that the proportion of households sampled during the wellbeing assessment that failed to produce a surplus represent a more accurate estimate of the size of this group.

In 2021, there were 156 (15.4%) within-PA households that failed to produce a surplus. Of these, 11 (7.0%) households participated in IBIS Rice. This is modest improvement from 2017, when 3 (3.5%) households that failed to produce a surplus sold rice to the programme. These figures also show that the proportion of households that fail to produce a surplus is lower than previous estimates made using the area of measured land for each family. This may in part be due to the distinction between the programme definitions of households and families, which mean that a household can be made up of multiple families. Consequently, while individual families may not produce a surplus, resource sharing within households means that a lower proportion of families goes without than would be expected.

These findings imply that, while progress towards improving programme access to poorer farmers has been slow, the importance of this recommendation - from the perspective of increasing take up - may have been overstated. However, improving access to poorer farmers has other benefits, including addressing the risk of exacerbating existing wealth inequalities, increasing programme legitimacy within communities and maximising potential for improving household wellbeing. It is therefore recommended that the programme continue to investigate and implement interventions aimed at increasing integration of poorer farmers.

8.2. INCREASE FARMERS UPTAKE

The results of a randomised control trial implemented as part of the previous round of the evaluation showed that IBIS Rice participants were significantly less likely to clear forest than farmers randomly assigned to a control group (Clements *et al.* 2020). However, an analysis of forest clearance at the landscape level undertaken at the same time detected no significant difference between villages in which IBIS Rice has been implemented and non-implementation villages. This discrepancy highlighted the importance of increasing uptake of the programme not only in new villages but also within villages currently included in the programme. Consequently, it was recommended that efforts be made to increase recruitment in existing villages, with a focus on villages with the greatest conservation value in surrounding forest.

As Table 4 (and other programme data) shows, participation rates have in fact fallen in the intervening period. This is a worrying trend, particularly in light of the increasing benefit that the programme offers participating farmers. Key challenges that remain to be addressed include: i) understanding how to incentivise farmers who have left the scheme to return, ii) marketing the programme to farmers that produce a surplus but have nevertheless never participated, and iii) developing a mechanism whereby farmers previously found to be non-compliant are permitted to return to the programme. In this regard, there is significant potential for adopting a behaviour centred approach, in which insights drawn from behavioural science can be tested to increase take up.

8.3. ADOPT A NEW APPROACH TO ADAPTIVE MANAGEMENT

The final recommendation drawn from the previous round of the evaluation was the adoption of an iterative process of A/B trials to assess incremental adjustments to programme activities. Under this process, promising new interventions or adaptations to existing programmes would be randomly assigned at either individual household (if appropriate) or village level to approximately half the target population (e.g. new participants in existing villages), while the remaining population would receive the existing standard programme model. This would allow for simple comparisons, using either quantitative or qualitative assessments, to understand whether the proposed changes improved the existing model. Where adaptations are found to increase programme impact, they are integrated into the existing model. Over time, this process provides a simple framework against which new ideas can be assessed and incremental improvements can be made. It can also provide a context for improved communication with

programme participants and open the way for greater use of participatory approaches to programme design, thereby increasing the legitimacy with which the programme is likely to be viewed by communities.

It is strongly recommended that an adaptive approach be adopted for testing ideas to increase recruitment for the 2022 growing season.

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