RESILIENCE IN NICARAGUA

Impact evaluation of climate change adaptation among small scale producers

Effectiveness Review Series   2014/15

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DAVID BISHOP & ROB FULLER

OXFAM GB

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EXECUTIVE SUMMARY

Oxfam GB's Global Performance Framework is part of the organisation's effort to better understand and communicate its effectiveness, as well as enhance learning across the organisation. Under this Framework, a small number of completed or mature projects are selected at random each year for an evaluation of their impact, known as an 'Effectiveness Review'. The project 'Climate Change Adaptation among Small Producers' in Nicaragua was one of those selected for an Effectiveness Review in the 2014/15 financial year.

The project was carried out by Oxfam and in partnership with the Centro para la Promoción, la Investigación y el Dessarollo Rural Social (the Centre for Promotion, Research and Rural Social Development, CIPRES) in three municipalities of the department of Chinandega in the west of Nicaragua, between early 2011 and October 2013. The objective of the Effectiveness Review, which was carried out in November and December 2014, was evaluating effectiveness of this project in enabling women producers and their households to strengthen their livelihoods and to minimise risk from shocks and adapt to emerging trends and uncertainty.

Evaluation approach

This Effectiveness Review used a quasi-experimental evaluation design to assess the impact of the activities among the women who directly participated in the project activities. The project assumed that women who participated directly in the project would subsequently pass on the knowledge and skills they had learned to other members of their local cooperatives. With this logic in mind, the Effectiveness Review planned to consider the direct effect of the project among those women who participated directly, and test whether the support provided to direct project participants created 'spillovers' among other members of the cooperatives. 101 of the 120 direct women participants were interviewed, as well as all other women members of the same local cooperatives (indirect beneficiaries) (a total of 76). For comparison purposes, 328 women were interviewed from among the membership of local cooperatives in nearby communities, where the project activities had not been carried out. At the analysis stage, to increase confidence when making estimates of the project's impact, the statistical tools of propensity-score matching and multivariate regression were used to control for apparent baseline differences between the households in the project and comparison communities.

The primary aim of the Effectiveness Review was to investigate the project's impact on building resilience to shocks and stresses. This was assessed by identifying 23 characteristics that are thought to be associated with resilience, for which data could be collected in the household survey. These characteristics were formulated under Oxfam's multidimensional framework for measuring resilience. Some of these indicators were directly related to the project activities, while others were 'higher level' outcomes on which the project was less likely to have an effect. A full list of indicators and a summary of the results for each is shown in Table 1.

Results

This Effectiveness Review found that this project has positively affected several important characteristics that are thought to be associated with resilience. On average, direct project participants met thresholds for positive scores in 58 per cent of the characteristics of resilience, compared to only 47 per cent of the characteristics among households in the comparison communities. The other cooperative members, on average, scored positively in 48 per cent of the resilience indicators compared to 42 per cent for their comparison group.

We can disaggregate the resilience index by looking at each of the 23 characteristics separately, to examine how these overall increases in resilience were achieved. As shown in Table 1, there were positive and significant changes for 12 out of the 23 indicators for the direct project participants, while for the other cooperative members, 8 of the indicators increased significantly.

Table 1: Characteristics of resilience examined in this Effectiveness Review

Dimension	Characteristic	Connected to project logic?	Positive and significant impact on:	
			Direct project participants?	Other cooperative members?
Livelihood viability	Land ownership	No	No	Yes
	Crop diversification	Yes	Yes	Yes
	Crop production	Yes	No	No
	Adoption of improved practices	Yes	Yes	Yes
	Access to markets	No	No	Yes
	Livelihood diversification	No	No	No
	Ownership of productive assets	No	Yes	No
Innovation potential	Understanding of climate change	Yes	Yes	No
	Adoption of new practices or initiatives	Yes	Yes	No
	Ability to influence others	Yes	Yes	No
	Access to credit	Yes	No	No
Access to contingency resources and support	Grain storage	Yes	No	No
	Savings	No	No	No
	Access to remittances or state support	No	No	No
Integrity of the natural and built environment	Location of house	No	No	No
	Access to safe drinking water	No	No	Yes
	Access to irrigation	No	No	No
	Tree planting	Yes	Yes	Yes
Social and institutional capability	Solidarity in the community	No	Yes	No
	Involvement in risk management and emergency preparedness committee	No	Yes	Yes
	Risk management plan	Yes	Yes	Yes
	Communal actions taken to mitigate risk	Yes	Yes	No
	Early-warning system	No	Yes	No

It emerges that the largest differences between the intervention and comparison households are connected to more 'output-related' characteristics, that is, indicators that are directly related to the project logic. This includes, for example, indicators of

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crop diversification, tree planting, and involvement in risk management committees. However, there was generally less evidence that measures of 'higher level' resilience outcomes, such as livelihood diversification, access to credit, and savings, were affected by the project.

Since this Effectiveness Review collected data on both direct project participants and other members of the same cooperatives (indirect beneficiaries), it was possible to investigate whether there had been any spillover effects. The results were somewhat mixed. For indicators of livelihood viability and social and institutional capability, it appears that other members of the cooperatives also benefited from the project. However, there was no evidence of spillovers for measures of innovation potential.

This Effectiveness Review also allowed us to evaluate the project's direct impact on agricultural activities and dietary diversity. The project increased households' use of kitchen gardens and forest pasture land, as well as supporting the use of organic fertilisers and crop rotation and mulching, but many of these improvements were restricted to the direct project participants. Participant households also had a more diversified crop portfolio than those in the comparison group. Correspondingly, consumption of fruit and vegetables was higher in the intervention group.

Even though the project was focused on resilience, we also conducted an exploratory analysis of women's empowerment outcomes, since the project had some specific objectives related to women's involvement in cooperatives and decision making. Although there was evidence of some modest increases in women's involvement in decision making, especially with regard to agricultural activities, these effects were only seen for the direct project participants. Moreover, there was no evidence that the project had any effect on many other indicators of women's empowerment, including land ownership, involvement in financial decisions, and time use.

The main results of the Effectiveness Review are summarised in Table 2.

Table 2: Key results of this Effectiveness Review

Outcome area		Linked to project logic	Positive and significant impact on:		Comments
			Direct project participants?	Other cooperative members?	
Resilience	Livelihood viability	Yes	Yes	Yes	Main evidence of impact on crop diversification and adoption of improved agricultural practices, among both direct project participants and other cooperative members.
	Innovation potential		Yes	No	Direct project participants had improved understanding of climate change and were more likely to adopt new practices or initiatives, but spillovers to the other cooperative members were limited.
	Access to contingency resources and support		No	No	No evidence of change in savings, access to remittances or state support, or grain storage, even though the latter was directly connected to the project logic.
	Integrity of natural and built environment		Yes	Yes	Evidence among both direct project participants and other cooperative members of increased tree planting.
	Social and institutional capability		Yes	Yes	Strong evidence of increased involvement in risk management and emergency preparedness committees as well as knowledge of risk management plan for both direct project participants and other cooperative members.
Agricultural activities		Yes	Mixed	Mixed	Evidence that the project increased the amount of land households devote to kitchen gardens and forest-pasture. Also increased use of organic fertilisers and crop rotation/mulching practices.
Dietary diversity		Yes	Yes	Yes	Evidence of increased consumption of fruit and vegetables, especially among the other cooperative members.
Women's empowerment		No	Very limited	No	Limited evidence that direct project participants were more involved in decisions around agricultural practices, but no evidence that women were more empowered over financial issues. No evidence that women's time use was affected by the project.

Learning considerations

While the findings of the Effectiveness Review are largely positive, there are additional lessons emerging from the results that can be applied to other projects of this type in Nicaragua and elsewhere. Through discussion with the country and project teams, and with input from partner staff, we are able to generate the following learning considerations:

Increase the emphasis on spillovers during the project design phase.

The project tried to create spillovers to other cooperative members and the community at large by training some participants as local promoters, who could pass on knowledge and establish demonstration plots on their land. Anecdotal evidence also suggests that project participants shared seeds and crops. However, this emphasis on spillovers was only brought in to the project towards the end of its implementation, and was not explicitly part of the design phase. This may explain why the results on spillovers are somewhat mixed. In particular, there is no evidence of spillovers on the dimension of innovation potential, where we hope to see understanding of climate change and new techniques permeating from the direct project participants through the

cooperatives. It is therefore recommended that, in order to have more profound effects on other cooperative members besides the direct project participants, it is necessary to make spillovers part of project design.

Take a more integrated approach, taking account of other actors working in the area.

Although the project had a positive overall effect on the resilience index, there was less evidence that higher-level outcomes, including wealth, were changed. In order to affect these types of outcomes, we may require better integration of projects like 'Climate change adaptation among small scale producers' with other activities being undertaken, not only by Oxfam, but also by other NGOs in the area. This reflects a 'systems thinking' approach, which takes into account and incorporates all the relevant actors and how they are linked during the design of the programme. This type of approach may also be supported by a monitoring and evaluation framework, which gives project staff information about changes in the system in a frequent and timely way.

Consider further research to investigate why some agricultural practices did not appear to change.

Although there were positive and significant differences for certain agricultural practices, such as the use of organic fertiliser and crop rotation/mulching, there were also some puzzles arising from the results of this Effectiveness Review. For example, although the project provided both training and inputs to help participants store grain, there were no significant differences in the number of households storing grain between the participant and comparison group. Similarly, project participants appeared to show no change in their use of improved seeds. While we can speculate about why this may be, our data do not allow us to unpack these results. We thus recommend further research to ascertain why these outcomes, which appear to be directly related to the project logic, changed far less than others.

1 INTRODUCTION

Oxfam GB's Global Performance Framework is part of the organisation's effort to better understand and communicate its effectiveness, as well as enhance learning across the organisation. Under this Framework, a small number of completed or mature projects are selected at random each year for an evaluation of their impact, known as an 'Effectiveness Review'. The project 'Climate Change Adaptation among Small Producers' in Nicaragua was one of those selected for an Effectiveness Review in the 2014/15 financial year.

The project was carried out by Oxfam and in partnership with the Centro para la Promoción, la Investigación y el Desarrollo Rural y Social (the Centre for Promotion, Research and Rural Social Development) (CIPRES) in three municipalities of the department of Chinandega in the west of Nicaragua, between early 2011 and October 2013. The Effectiveness Review, which was carried out in November and December 2014, was aimed at evaluating the success of this project for women producers and their households in strengthening their livelihoods and minimising risk from shocks, and adapting to emerging trends and uncertainty.

This report presents the findings of the Effectiveness Review. Section 2 briefly reviews the activities and the intervention logic of the project. Section 3 describes the evaluation design used and Section 4 describes how this design was implemented. Section 5 presents the results of the data analysis, based on the comparison of outcome measures between the intervention and comparison groups. Section 6 concludes with a summary of the findings and some considerations for future learning.

2 PROJECT DESCRIPTION

The project under review aimed to improve small producers' understanding of the impacts of climate change and to build their capacity to adapt to any changes it causes. The project arose from a concern that the impact of climate change on rural livelihoods in the north-west of Nicaragua was becoming more severe, with increased patterns of irregular rainfall and prolonged dry seasons leading to soil degradation, the emergence of new crop diseases, and food crises. Smallholder farmers were seen as lacking information about these changes and what they could do to reduce their risks, and were continuing to use traditional production techniques that left them increasingly vulnerable.

This project built on agricultural development work carried out by CIPRES in the region since the 1990s. After the destruction in the region by Hurricane Mitch in 1998, CIPRES and Oxfam together launched the Programa Productivo Alimentario (PPA) (Food Production Programme) in Chinandega's neighbouring department of Léon, Under this programme, approximately 420 households were targeted with distributions of seeds and livestock and with training and technical support. As part of this and subsequent programmes, CIPRES facilitated the creation of local producers' cooperatives, including women-only cooperatives in several areas. In 2007 the PPA programme was used as a model for a nationwide government food-security programme known as 'Hambre cero' (Zero Hunger).[1]

The project under review was launched in 2010. The partners began by carrying out an assessment among dozens of cooperatives in the department of Chinandega: seven cooperatives were selected as being in areas particularly vulnerable to climate-related risks. Five of these cooperatives were members of the networks supported by CIPRES, while two were not. Within these cooperatives, 120 smallholder producers – all female bar one – were selected to participate directly in the project activities. The majority of these women were existing members of the cooperatives. In some cases, women who were spouses or partners of male cooperative members were selected as project participants.

Between 2010 and 2013, the 120 project participants received a programme of support, including training on improved techniques for crop production and soil management, on the selection and storage of seeds, on livestock management, and on protection of the local environment. A key element of these activities was to build understanding of climate change and its effects on food security and livelihoods, and to encourage experimentation and adaptation in productive activities. All the project participants also received distributions of seeds and tools, while some were provided with metal silos for grain storage, biodigesters (for producing gas from organic waste for cooking) or ecological latrines. A revolving credit fund was established within each cooperative, and project participants were asked to contribute 20 per cent of the value of any inputs or support they received to the fund, so that it could be lent to members for productive investments. Project participants were also supported in establishing and running risk management committees. Visits to exchange experiences with producers in other areas were also organised.

The project aimed to have an impact not just on the 120 direct participants and their households, but also on the wider population of their communities. The programme of support to the direct project participants ended in early 2013, and those participants were then particularly encouraged to raise awareness of what they had learned among other members of their cooperatives and among their neighbours. Also, during the project, specific participants were trained as local promoters, and established demonstration plots on their land. However, this emphasis on creating 'spillovers' from

the main project participants to others was not part of the project design phase, and was only brought in towards the end of the project cycle.

The messages promoted by the project were reinforced through a radio programme, 'Un planeta verde para todos y todas' ('A Green Planet for All'), which was broadcast on local radio throughout the department of Chinandega in 2012. It should be noted that, since this radio programme was listened to in the project and the comparison communities included in this Effectiveness Review, its impact could not be evaluated.

3 EVALUATION DESIGN

The central problem in evaluating the impact of any project or programme is how to compare the outcomes that result from that project with *what would have been the case* without that project having been carried out. In the case of this Effectiveness Review, information about the situation of households in the project communities was collected through a household questionnaire – but clearly it was not possible to know what their situation would have been had the project activities not been carried out. In any evaluation, that 'counterfactual' situation cannot be directly observed: it can only be estimated.

In the evaluation of programmes that involve a large number of units (whether individuals, households, or communities), common practice is to make a comparison between units that were subject to the programme and those that were not. As long as the two groups can be assumed to be similar in all respects except for the implementation of the specific project, observing the situation of those where the project was not implemented can provide a good estimate of the counterfactual.

An ideal approach to an evaluation such as this is to select the sites in which the programme will be implemented at random. Random selection minimises the probability of there being systematic differences between the project participants and non-participants, and so maximises the confidence that any differences in outcomes are due to the effects of the project.

In the case of the project examined in this Effectiveness Review, the communities where the project was implemented were not selected at random. Instead, the partners targeted specific communities that were seen to be particularly vulnerable to climate-related risks, and where there was potential for the project activities to contribute to reduce vulnerability. However, it is clear that producers across the region face similar risks, so there were other communities where the project activities could have been implemented. This allowed a 'quasi-experimental' evaluation approach to be adopted, in which the situation of people living in communities not included in the project was assumed to provide a reasonable counterfactual for the situation of people who participated in the project.

It is important to note that within the project communities, those who participated in the project communities were not selected at random. Instead, all the project participants were themselves already members of local producers' cooperatives, or were the spouses or partners of men who were members of those cooperatives. In most communities, only a minority of households are represented among the membership of these local cooperatives. It is likely that these people who have chosen to join the cooperatives tend to differ from their neighbours who have not – for example, in their sense of initiative, willingness to take risks, or in their social connections. It was therefore important, for comparison purposes, to interview people in the comparison communities with similar traits. This was done by identifying cooperatives in the comparison communities that were similar to those supported by the project, and interviewing the female members of those cooperatives and the spouses or partners of male cooperative members.

To improve the confidence in making the comparison of outcomes, households in the project communities were 'matched' with households with similar characteristics in the non-project (or 'comparison') communities. Matching was performed on the basis of a variety of characteristics – including household size, ethnicity, education level, productive activities, and indicators of material wellbeing, such as housing conditions and ownership of assets. Since some of these characteristics may have been affected

by the project itself (particularly those relating to productive activities and wealth indicators), matching should be performed on the basis of these indicators *before* the implementation of the project. Although baseline data were not available in this case, all survey respondents were asked to recall some basic information about their household's situation in 2010, before the project was implemented. Although this recall data is unlikely to be completely accurate, it is thought to enhance the reliability of the comparison used to make conclusions in this report.

The survey data provided a large number of baseline household characteristics on which matching could be carried out. (The characteristics that were in fact used are listed in Appendix 2.) One practical problem is that it would be very difficult to find households in the comparison communities that correspond exactly in all these characteristics to households in the project communities. Instead, these characteristics were used to calculate a 'propensity score', the conditional probability of the household being in an intervention community, given particular background variables or observable characteristics. Households in the project and comparison communities were then matched based on their having propensity scores within certain ranges. Tests were carried out after matching to assess whether the distributions of each baseline characteristic were similar between the two groups. Technical details of this approach are described in Appendix 3.

As a check on the results derived from the propensity-score matching process, results were also estimated using multivariate regression models. Like propensity-score matching, multivariate regression also controls for measured differences between intervention and comparison groups, but it does so by isolating the variation in the outcome variable explained by being in the intervention group after the effects of other explanatory variables have been accounted for.

It should be noted that both propensity-score matching and multivariate regression rely on the assumption that the 'observed' characteristics (those that are collected in the survey and controlled for in the analysis) capture all of the relevant differences between the two groups. If there are 'unobserved' differences between the groups, then estimates of outcomes derived from them may be misleading. This is a cause for particular caution when interpreting the results of an evaluation for a project in which participants were to some extent self-selected. This point is further discussed in interpreting the statistical results in Sections 5 and 6.

4 DATA

4.1 RESPONDENTS INTERVIEWED

All of the 119 women who had directly participated in the project activities were targeted to be interviewed in this Effectiveness Review. In order to provide an indication of the impact of the project among the wider population, all other female members of the project cooperatives were also interviewed.

The lists of direct project participants were obtained from CIPRES's records, with some corrections made during discussion with the cooperative presidents. In some cases the lists of other members of the project cooperatives were available from CIPRES's records, and in other cases were obtained directly from cooperative presidents. In the event, 101 of the 119 female direct project participants were interviewed. Of the 111 women who were members of the same cooperatives, but who did not receive direct support from the project (the indirect beneficiaries), 76 were interviewed. These other members were essentially 'indirect participants', i.e. members of the same cooperatives as the direct project participants. In most of the remaining cases, the person to be targeted for interview had moved away from the area. (In addition, a small number of direct project participants or other cooperative members were excluded because there were two cooperative members from the same household. Only one person from each household was interviewed.)

For comparison purposes, the Effectiveness Review team identified a number of producers' cooperatives in communities in two municipalities where the project was implemented, as well as in the nearby municipality of Villanueva. As with the project cooperatives, some had been included in previous CIPRES programmes and are part of the networks supported by CIPRES, while others were not. Cooperatives that had received extensive support from other organisations during the past few years, or that were thought to have been significantly more developed than the project cooperatives before the project started, were excluded from the survey. Selection of these cooperatives was carried out carefully with the programme team and the partners to obtain an appropriate counterfactual.

Most of the 119 direct female participants in the project under review were already members of the project cooperatives in 2010. However, a minority of them were not themselves cooperative members, but were in fact the partners of male members of certain cooperatives. To find a comparable population in the comparison cooperatives, the partners of male cooperative members were targeted for interview, as well as women who were members of the cooperative in their own right. In each of the comparison cooperatives, all of the female members and partners of the male members were targeted for interview.

Table 4.1: Intervention communities and sample sizes

Municipality	Community	Direct project participants interviewed	Other women members of the project cooperatives interviewed
El Viejo	Virgen del Hato	17	16
	Pedro Altamirano	35	0
Chinandega	Rancherías	12	9
	Ojo de Agua	9	9
Posoltega	El Tanque	14	16
	Santa María	9	17
	Posolteguilla	5	9
Total		**101**	**76**

Table 4.2: Comparison communities and sample sizes

Municipality	Community	Women cooperative members and partners of male cooperative members interviewed
El Viejo	La Bayona & Mata de Cacao	23
	Palo Herrado	15
	Santa Rita & Quilaka	25
	Apascalí (two cooperatives)	51
Chinandega	San Juan de las Pencas	14
	Villa 15 de Julio	22
	El Rosario	20
Villanueva	Pacaira (two cooperatives)	21
	Paguil (two cooperatives)	26
	Mayucunda	19
	Rincon García	29
	Genizaros-Zapotes	30
	Mina de Agua	15
	Los Tololos	18
Total		**328 (out of 330)**

4.2 ANALYSIS

Households in project and comparison communities were compared in terms of their demographic characteristics, livelihoods activities and economic situation in 2010 (that is, before the project was launched). These data were based on information recalled during the questionnaire or reconstructed from the household's composition at the time of the survey.

The full comparison is shown in Appendix 2. Some important differences were found between the project and comparison households. For example, a higher proportion of households in the sample of project respondents (intervention group) were female-headed (33 per cent). Also, project households owned a smaller area of land (5.8 manzanas[2]) than comparison households (9.5 manzanas) in 2010. There were also significant differences in the education level, livelihoods activities in 2010, reported support received from Programa Productivo Alimentario and the geographic location (distance to the nearest town) between the project and comparison households. Respondents have apparently confused support they received from the current project with support from PPA. Importantly project participants were also significantly wealthier than the comparison group before the project.

These differences that existed before the project have the potential to bias any comparison of the project's outcomes with the comparison households. It was therefore important to control for these baseline differences when making such comparisons. As described in Section 3, the main approach used to control for the baseline differences

was propensity-score matching (PSM). The full details of the matching procedure applied are described in Appendix 3. After matching, the project and comparison households were reasonably well-balanced in terms of the recalled baseline data, with few significant differences between them. One important caveat is that 10 of the 101 direct project participants interviewed, and 9 of the 76 other members of the project cooperatives could not be matched and had to be dropped from the analysis. The consequence of this is that the results of the project's impact presented in Section 5 are not based on the whole population interviewed.

All the results described in Section 5 were tested for robustness using several alternative statistical models, including alternative PSM models and linear or probit regression models. Some of these alternative models were constructed using the same subset of households as used to construct the primary PSM model, while others were constructed using the full set of respondents interviewed. There is a discussion in Section 5 in the text or in footnotes of instances where the alternative statistical models produce markedly different results from those shown in the tables in this section.

It is important to recall, as highlighted in Section 3, that PSM and regression models can control only for the baseline differences between the members of the project and comparison cooperatives for which data was collected in the survey. If there are any 'unobserved' pre-existing differences between the two groups – such as individuals' attitudes, motivation, skills or confidence – then these may bias the estimates of outcomes described in Section 5. Given that the direct project participants are a self-selected group, this possibility cannot be excluded and must be borne in mind when interpreting the results.

5 RESULTS

This report is intended to be free from excessive technical jargon, with more detailed technical information being restricted to the appendixes and footnotes. However, there are some statistical concepts that cannot be avoided in discussing the results. In this report, results will usually be stated as the average difference between households living in villages where the project was implemented (that is referred to as the 'intervention group') and the matched households in villages where the project was not implemented (named the 'comparison group'). In the tables of results on the following pages, statistical significance will be indicated with asterisks, with three asterisks (***) indicating a p-value of less than 10 per cent, two asterisks (**) indicating a p-value of less than 5 per cent and one asterisk (*) indicating a p-value of less than 1 per cent. The higher the p-value, the less confident we are that the measured estimate reflects the true impact, rather than arising simply from random variation the data. Results with a p-value of more than 10 per cent are not considered to be statistically significant because in these instances, there is more than a 10 per cent chance that the results are due to random variation rather than the reflecting the true impact.[3]

5.1 INTRODUCTION

This section presents a comparison of the households interviewed in project and comparison communities in terms of various outcome measures relating to the project under review.

The results are shown after correcting for baseline differences between the households interviewed in the project communities (the 'intervention group') and those in the comparison communities using a propensity-score matching (PSM) procedure. More information about the procedure applied can be found in Appendix 3. All outcomes discussed here have also been tested for robustness with alternative statistical models. There is a discussion in the text or in footnotes of instances where these alternative statistical models have produced markedly different results from those shown in the tables in this section.

It is important to stress that the results presented in this section are average results across the whole intervention group, and then disaggregated for the direct project participants and other cooperative members.

Two further points should be borne in mind when interpreting the results presented in this section. Firstly, a number of the women surveyed in the project communities (19 of the 177 interviewed) were excluded from the analysis during the matching process because a suitable match could not be found. This means that the results shown in the tables in this section are not based on the full sample of households in the project communities. However, some of the alternative statistical models tested (and discussed in the text or in footnotes where appropriate) do include the full set of households interviewed in the project communities. Secondly, if there are any 'non-observable' differences between the households surveyed in project and comparison communities – such as individuals' attitudes or motivation, differences in local leadership, weather or other contextual conditions – then these may affect the estimates of outcomes. Given that the direct project participants are a self-selected group, this possibility cannot be excluded and must be borne in mind when interpreting the results.

5.2 INVOLVEMENT IN PROJECT ACTIVITIES

The first step in understanding what impact this project has had is to examine the extent to which respondents reported that they have received the types of support and participated in the various activities implemented under the project. Tables 5.1 to 5.3 show the differences between the proportions of respondents interviewed in the project and comparison communities in terms of support received by their households since 2010.

Columns 1 to 9 of Table 5.1 present the proportion of households reporting receipt of various types of training since 2010. It is clear from the table that a greater proportion of project households reported receiving the various trainings – particularly those trainings related to agricultural methods or approaches. For these particular trainings, at least 50 per cent of households reported attending. Fewer households reported receiving training on livestock management or preparing livestock feed (39 per cent overall) and the differences between the proportion of project and comparison households receiving the training were slightly less marked. Further, less than 50 per cent of project households received training on risk management. It is also important to note that among the direct project participants, a greater proportion of households reported receiving training compared to other women cooperative members.

The first two columns in Table 5.2 report on two other training topics – climate change and women's rights. In both cases, more than half of the intervention households reported receiving the training. However, there are only significant differences between the intervention and comparison households reporting receipt of training among the direct project participants. Interestingly, a large proportion of both intervention and comparison households (71 per cent and 61 per cent overall, respectively) have received training on women's rights since 2010. In part, this may reflect the large presence of other NGOs in this area of Nicaragua. We should, therefore, be somewhat cautious about the comparison observations when assessing women's rights issues. It does not seem to be plausible to assume that just because they did not receive training from the Oxfam project they did not receive any support at all.

Columns 3 to 9 of Table 5.2 present the proportion of households receiving various items or inputs since 2010. With the exception of cattle and barbed-wire distribution and pond treatment, a significantly greater proportion of project households reported receiving inputs compared with the comparison households. Among the direct project participants and their comparators, the differences are greater, and there is a significant positive difference in the proportion of households reporting receipt of barbed wire. Importantly, there are no positive statistically significant differences between the other cooperative member households and the comparison households in terms of those reporting receipt of the various items or inputs.

The first column of Table 5.3 reports on the proportion of households where the respondent had visited a demonstration plot or had taken part in an exchange visit with other producers. Among the direct project participants, 57 per cent had participated in such a visit, compared to 27 per cent of other cooperative members. Additionally, almost half of the direct project participant households (column 2) reported that they have had or currently have a demonstration plot, compared to 17 per cent of other cooperative member households. The final column of Table 5.3 reports on the proportion of households who have listened to the radio programme 'Un planeta verde para todos y todas' (A green planet for everyone). Overall, just over a quarter of intervention households had listened to the programme, compared with 32 per cent of the direct project participants.

Table 5.1: Proportion of households having received support since 2010

	1 Some household member has participated in training on soil management since 2010 %	2 Some household member has participated in training on crop management since 2010 %	3 Some household member has participated in training on soil/water conservation since 2010 %	4 Some household member has participated in training on harvest/post-harvest processing since 2010 %	5 Some household member has participated in training on livestock management since 2010 %	6 Some household member has participated in training on seed storage since 2010 %	7 Some household member has participated in training on organic fertiliser since 2010 %	8 Some household member has participated in training on livestock feed preparation since 2010 %	9 Some household member has participated in training on risk management since 2010 %
Overall									
Intervention group mean:	67.1	69.6	57.1	54.7	38.5	58.4	65.2	44.7	45.3
Comparison group mean:	47.8	53.1	41.2	35.0	30.0	42.0	42.5	30.4	29.1
Difference:	19.3*** (5.74)	16.5*** (5.38)	15.9*** (5.74)	19.7*** (5.51)	8.56 (5.44)	16.4*** (5.76)	22.7*** (5.52)	14.4*** (5.50)	16.3*** (5.54)
Observations (intervention group):	161	161	161	161	161	161	161	161	161
Observations (total):	482	482	482	482	482	482	482	482	482
Direct project participants									
Intervention group mean:	75.8	79.1	68.1	64.8	51.6	76.9	73.6	56.0	50.5
Comparison group mean:	45.0	51.2	43.7	36.1	29.7	43.9	43.6	28.6	29.4
Difference:	30.8*** (6.94)	27.9*** (7.05)	24.4*** (7.25)	28.8*** (7.46)	22.0*** (6.72)	33.1*** (7.02)	30.0*** (7.28)	27.4*** (6.76)	21.2*** (7.37)
Observations (intervention group):	91	91	91	91	91	91	91	91	91
Observations (total):	410	410	410	410	410	410	410	410	410
Other cooperative members									
Intervention group mean:	56.7	56.7	44.8	44.8	23.9	34.3	53.7	28.4	38.8
Comparison group mean:	56.8	52.5	35.9	30.7	27.4	41.4	40.3	28.3	25.1
Difference:	-0.10 (7.62)	4.19 (8.74)	8.89 (9.31)	14.0* (8.17)	-3.54 (8.31)	-7.05 (7.75)	13.4 (8.23)	0.10 (8.20)	13.7* (7.75)
Observations (intervention group):	67	67	67	67	67	67	67	67	67
Observations (total):	257	257	257	257	257	257	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1000 repetitions, with standard errors clustered by community.

Table 5.2: Proportion of households having received support since 2010 – continued

	1	2	3	4	5	6	7	8	9
	Some household member has participated in training on climate change since 2010 %	Some household member has participated in training on women's rights since 2010 %	Household has received distribution of agricultural inputs since 2010 %	Household has received distribution of metal silos since 2010 %	Household has received distribution of cattle since 2010 %	Household has received construction of a biodigester since 2010 %	Household has received construction of an ecological latrine since 2010 %	Household has received pond treatment since 2010 %	Household has received distribution of barbed wire since 2010 %
Overall									
Intervention group mean:	58.4	71.4	31.1	64.0	30.4	18.0	44.7	25.5	39.1
Comparison group mean:	33.0	60.9	22.8	24.2	39.5	10.3	32.9	33.3	31.8
Difference:	25.3*** (5.60)	10.5* (5.36)	8.25* (5.00)	39.8*** (4.99)	-9.03 (5.61)	7.73* (4.16)	11.8** (5.58)	-7.80 (5.07)	7.32 (5.51)
Observations (intervention group):	161	161	161	161	161	161	161	161	161
Observations (total):	482	482	482	482	482	482	482	482	482
Direct project participants									
Intervention group mean:	79.1	80.2	33.0	86.8	37.4	24.2	54.9	27.5	46.2
Comparison group mean:	30.8	63.8	20.8	24.8	36.4	9.67	39.2	33.3	27.6
Difference:	48.4*** (6.41)	16.4*** (6.18)	12.2** (6.15)	62.0*** (5.97)	0.92 (7.19)	14.5*** (5.55)	15.7** (7.40)	-5.87 (6.87)	18.5*** (7.17)
Observations (intervention group):	91	91	91	91	91	91	91	91	91
Observations (total):	410	410	410	410	410	410	410	410	410
Other cooperative members									
Intervention group mean:	31.3	61.2	25.4	32.8	22.4	7.46	29.9	17.9	31.3
Comparison group mean:	31.3	50.1	23.1	25.5	47.7	8.38	23.5	35.5	34.3
Difference:	0.067 (8.68)	11.1 (8.96)	2.31 (7.81)	7.35 (8.39)	-25.3*** (8.28)	-0.92 (4.50)	6.32 (6.55)	-17.6** (8.16)	-2.95 (9.20)
Observations (intervention group):	67	67	67	67	67	67	67	67	67
Observations (total):	257	257	257	257	257	257	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Table 5.3: Proportion of households having received support since 2010

	1 Respondent has visited a demo plot or had an exchange visit with other producers since 2010 %	2 Household has had, or currently has a demonstration plot %	3 Members of the household have listened to the radio programme: 'A green planet for everyone' %
Overall			
Intervention group mean:	44.7	32.5	27.3
Comparison group mean:	26.7	9.24	14.7
Difference:	18.0*** (5.42)	23.3*** (6.21)	12.6*** (4.68)
Observations (intervention group):	161	160	161
Observations (total):	482	475	482
Direct project participants			
Intervention group mean:	57.1	45.1	31.9
Comparison group mean:	23.7	14.3	14.7
Difference:	33.4*** (6.89)	30.8*** (8.73)	17.1*** (6.05)
Observations (intervention group):	91	91	91
Observations (total):	410	404	410
Other cooperative members			
Intervention group mean:	26.9	16.7	19.4
Comparison group mean:	24.6	6.43	15.2
Difference:	2.23 (8.52)	10.1 (7.04)	4.22 (6.97)
Observations (intervention group):	67	66	67
Observations (total):	257	252	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

5.3 AGRICULTURAL ACTIVITIES

We now turn to examining evidence for the project's impact on the various outcomes that it sought to affect. The first outcome area to be considered is the project's impact on agricultural activities.

Table 5.4 shows the difference between project and comparison households in terms of several indicators of households' access to and use of land. It can be seen from column 2 of Table 5.4 that interviewed households farmed approximately 1.6 manzanas[4] of land on average during the year of the survey, and that this figure was higher among direct project participants (1.9) than in other cooperative member households (0.9). There does not appear to be any significant difference between the project and comparison households in terms of the total area of land farmed, nor (as shown in column 1) in the total area of land owned by the households. Similarly there are no obvious and significant differences in the area of irrigated land among the two groups, although this may be because irrigation tends to be small scale in both the participation and the comparison group. Indeed, column 3 shows that only a very small proportion of the households' cultivated land is irrigated (an average of 0.06

manzanas). Finally, column 4 demonstrates that there are no statistically significant differences in the area of land owned by the respondents themselves.

Table 5.4: Land use

	1	2	3	4	5	6
	Land area owned by household (manzanas)	Land area cultivated in the past 12 months (manzanas)	Land area irrigated in the past 12 months (manzanas)	Land area owned by the respondent (manzanas)	Household has a kitchen garden %	Household has forest-pasture land %
Overall						
Intervention group mean:	5.94	1.61	0.056	3.21	28.0	29.2
Comparison group mean:	5.75	1.75	0.099	3.38	16.1	14.6
Difference:	0.19 (0.82)	-0.14 (0.30)	-0.043 (0.035)	-0.17 (0.73)	11.8*** (4.48)	14.6*** (4.73)
Observations (intervention group):	161	161	161	161	161	161
Observations (total):	482	482	482	482	482	482
Direct project participants						
Intervention group mean:	7.30	1.88	0.055	3.79	34.1	40.7
Comparison group mean:	6.98	1.87	0.079	3.44	21.8	14.8
Difference:	0.32 (1.25)	0.010 (0.27)	-0.024 (0.037)	0.35 (1.04)	12.2** (6.09)	25.9*** (5.93)
Observations (intervention group):	91	91	91	91	91	91
Observations (total):	410	410	410	410	410	410
Other cooperative members						
Intervention group mean:	3.58	0.87	0.041	2.00	20.9	14.9
Comparison group mean:	2.92	1.14	0.072	1.72	12.0	10.9
Difference:	0.65 (0.63)	-0.27 (0.25)	-0.031 (0.040)	0.28 (0.49)	8.89 (6.84)	4.00 (6.13)
Observations (intervention group):	67	67	67	67	67	67
Observations (total):	257	257	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Where there is some indication of a difference between the project and comparison households is in terms of whether households had a kitchen garden or forest-pasture

land. The project encouraged using land in this way, given its focus on climate change. Table 5.4 shows that the differences are significant for both of these among direct project participants. In addition, the other PSM and regression models suggest that the difference is also significant for the other members of the project cooperatives – at least in terms of households having a kitchen garden. This is especially interesting as it demonstrates a potential positive spillover effect from the project. In particular, project and partner staff suggested that this spillover effect occurred because participants shared their seeds and crops, and others replicated their cultivation practices.

Table 5.5 examines differences between the project and comparison households in reported adoption of some of the improved agricultural techniques encouraged under the project. (These results are also shown graphically in Figure 5.1.) The first column shows those who reported having used organic fertiliser. Although only around 30 per cent overall had used organic fertiliser, this applied to a much larger proportion in the project households than in the comparison households. About 35 per cent of those who were direct project participants reported having used organic fertiliser, compared to 22 per cent of households of other cooperative members. The results are very similar for the use of organic pesticide with significant differences between the project households and comparison households. Again, these results suggest positive spillover effects between the direct project participants and the other cooperative members.

Columns 3 to 8 of Table 5.5 show the reported adoption of other improved agricultural techniques – including the use of a hand-spike for sowing, the practice of crop rotation and mulching, the use of improved seeds, and the storage of grain or seed.

Figure 5.1: Percentage of households reporting improved agricultural practices since 2010
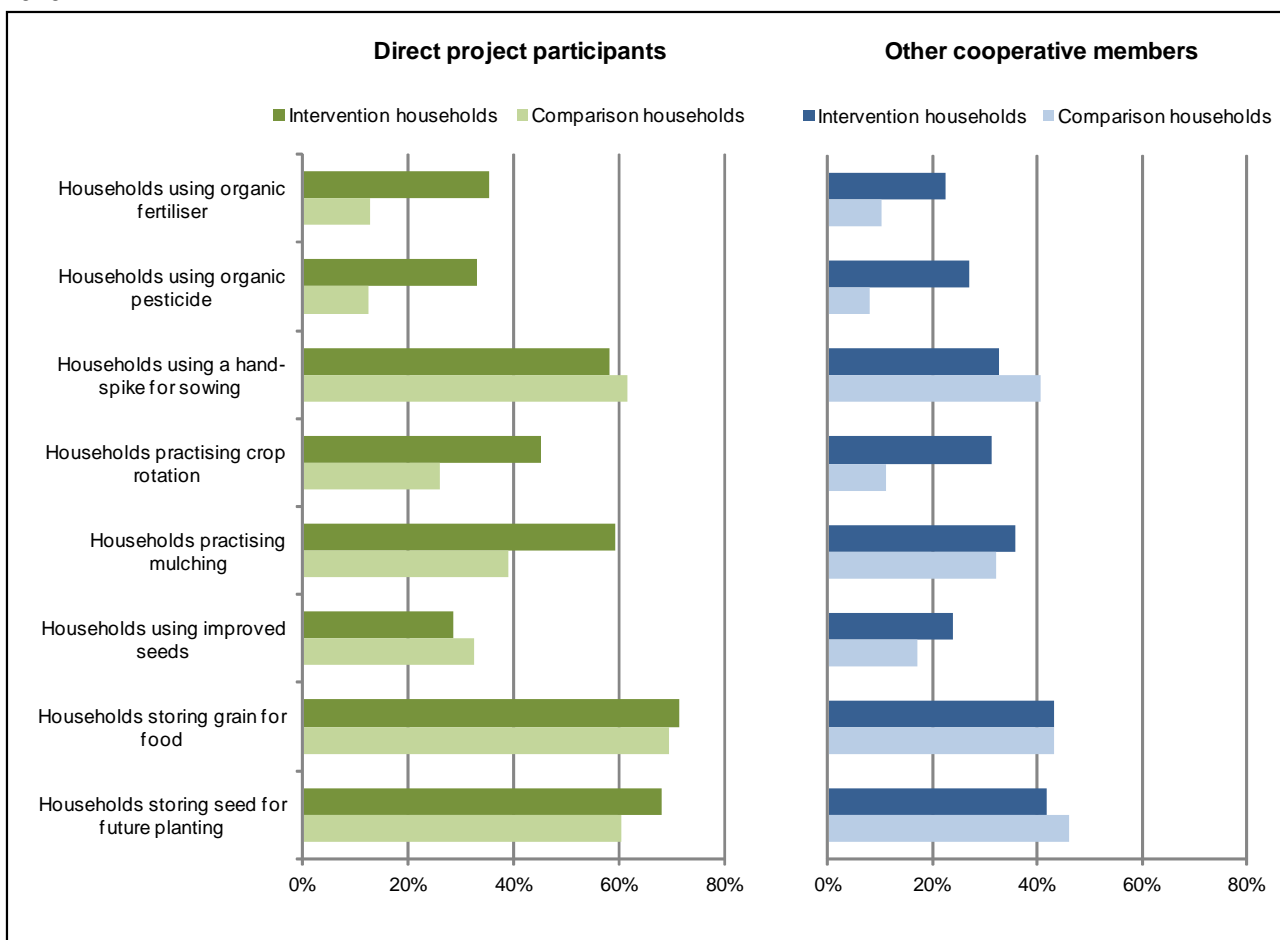
With the exception of the practices of crop rotation and mulching, there are no significant differences between project and comparison communities in the adoption of

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these other techniques. Approximately 40 per cent of households in project communities reported practising crop rotation – 45 per cent among direct project participant households and 31 per cent among other cooperative member households – which is around twice the proportion of households in the respective comparison communities reporting the same. In terms of households practising mulching, a significantly higher proportion of direct project participant households reported adoption of this technique, but there was no difference between the other cooperative member households and the comparison households.

The techniques reporting greatest adoption were the storage of grain for food and the storage of seed, although in both cases there were no significant differences between the project and comparison communities. It is of course possible that there were differences between the groups in the quantities or quality of grain and seed stored, which these simple yes/no questions would not detect.

Overall, the project placed greater emphasis on supporting crop practices, such as rotation and mulching, compared with using improved seeds. Moreover, the use of improved seeds may have been hampered by the variability of winter temperatures during the course of the project, which affected project participants' ability to multiply their seeds. This may partially explain the main patterns in Table 5.5. However, further research would be required to examine these potential explanations in more detail.

Table 5.5: Adoption of improved agricultural techniques

	1	2	3	4	5	6	7	8
	Households using organic fertiliser since 2010 %	Households using organic pesticide since 2010 %	Households using a hand-spike for sowing since 2010 %	Households practising crop rotation since 2010 %	Households practising mulching since 2010 %	Households using improved seeds since 2010 %	Households storing grain for food since 2010 %	Households storing seed for future planting since 2010 %
Overall								
Intervention group mean:	29.8	30.4	47.2	39.1	49.1	24.8	60.2	57.8
Comparison group mean:	14.6	11.6	51.5	19.2	36.5	25.4	60.9	56.4
Difference:	15.3*** (4.70)	18.9*** (4.40)	-4.29 (5.68)	20.0*** (5.07)	12.6** (5.70)	-0.55 (4.88)	-0.67 (5.75)	1.41 (5.64)
Observations (intervention group):	161	161	161	161	161	161	161	161
Observations (total):	482	482	482	482	482	482	482	482
Direct project participants								
Intervention group mean:	35.2	33.0	58.2	45.1	59.3	28.6	71.4	68.1
Comparison group mean:	12.9	12.4	61.7	26.0	39.0	32.6	69.4	60.5
Difference:	22.3*** (6.39)	20.5*** (5.78)	-3.51 (6.94)	19.1*** (7.02)	20.4*** (7.49)	-3.98 (7.09)	1.98 (6.47)	7.68 (7.48)
Observations (intervention group):	91	91	91	91	91	91	91	91
Observations (total):	410	410	410	410	410	410	410	410
Other cooperative members								
Intervention group mean:	22.4	26.9	32.8	31.3	35.8	23.9	43.3	41.8
Comparison group mean:	10.3	8.07	40.5	11.2	32.2	17.0	43.3	46.0
Difference:	12.1** (5.95)	18.8*** (6.20)	-7.70 (8.74)	20.1*** (6.90)	3.62 (8.60)	6.86 (7.24)	-0.021 (8.91)	-4.17 (8.83)
Observations (intervention group):	67	67	67	67	67	67	67	67
Observations (total):	257	257	257	257	257	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Tables 5.6a and 5.6b examine the evidence for an effect of the project on the production and sale of crops respectively. Respondents were asked for details of all the crops they had produced during the previous 12 months, with estimations of the quantities harvested and sold, and the prices at which those sales were made.

The first point to note is that approximately 30 per cent of both project and comparison households reported not growing any crops. However, as can be seen from column 1 of Table 5.6a, there is an indication of an overall difference between the project and comparison households in the diversity of crop types produced. On average, households in project communities produce 2.2 crops compared to 1.5 crops in comparison households. The difference is significant only among households of direct project participants. Column 2 suggests that the number of crops cultivated by both project and comparison households has actually reduced slightly since 2010. However the reduction is significantly less among direct project participants than their comparators.

In terms of the total quantity (by weight) of crops harvested, the questionnaire only collected this information for maize, rice and beans. These results are shown in columns 3 to 5. The overall results for rice and beans are somewhat surprising as only 1.4 quintales[5] and 0.7 quintales respectively were harvested on average. This may be because the survey area was relatively poor, so rice and bean production is below average. However, there may also have been some difficulties in collecting the data, as respondents were required to recall all the different types of crops they produced. That said, the direct project participants harvested a greater quantity of rice (1.9 quintales) than their comparators (0.6 quintales), as we can see in column 4. In terms of maize production (column 3) there is little evidence of any positive difference between the project and comparison communities. In fact there is evidence that households in the project communities produced significantly less maize than households in the comparison communities. This may suggest that households in project communities are involved in cultivating a range of other crops at the expense of maize. Although the project distributed new types of maize seeds (NB-6 and NB-S), there was also support for growing other varieties of crops. Interestingly there is some evidence to suggest that among households of direct project participants a greater proportion of their maize harvest is consumed rather than sold. This may help to interpret some of the results on crops sales reported below.

Turning to Table 5.6b, it appears that there are no differences in the proportion of project and comparison households selling crops (column 1), with just under half of households reporting that they had sold at least one crop in the previous 12 months. The crop data collected in the survey also allows an estimate of the total value of crops sold (gross revenue – i.e. it does not exclude costs of production) during the 12-month period to be calculated. Columns 3 and 4 show the total revenue earned from cereal and all crops in the previous 12 months. While the project households appear to be earning significantly less revenue than the comparison households, when the figure for total revenue is shown after logarithmic transformation (column 5), the differences are no longer significant – suggesting no significant difference in the revenue being generated between project and comparison households.[6]

Overall, then, the survey results provide good evidence that the project has been successful in encouraging producers to adopt some of the improved agricultural techniques – including the use of organic fertiliser and pesticide, and the practices of crop rotation and mulching – as well as in establishing kitchen gardens. There is also some evidence of a greater range of crops being produced among those who were direct project participants. However, these changes do not yet appear to have resulted in significant increases in the value of crop sales.

Table 5.6a: Agricultural production

	1	2	3	4	5
	Number of crop types produced in the past 12 months	**Change in number of crop types produced since 2010**	**Quantity of maize produced (Quintales)**	**Quantity of rice produced (Quintales)**	**Quantity of beans produced (Quintales)**
Overall					
Intervention group mean:	2.24	-0.36	8.83	1.39	0.67
Comparison group mean:	1.54	-1.00	14.3	0.77	0.46
Difference:	0.70*** (0.24)	0.64** (0.27)	-5.42** (2.33)	0.62 (0.57)	0.22 (0.27)
Observations (intervention	160	160	161	161	161
Observations (total):	482	482	482	482	482
Direct project participants					
Intervention group mean:	2.48	-0.55	11.2	1.93	0.53
Comparison group mean:	1.73	-1.25	17.1	0.55	0.49
Difference:	0.76*** (0.29)	0.70* (0.38)	-5.89* (3.17)	1.39* (0.75)	0.042 (0.31)
Observations (intervention	91	91	91	91	91
Observations (total):	410	410	410	410	410
Other cooperative members					
Intervention group mean:	1.67	-0.11	5.20	0.81	0.78
Comparison group mean:	1.28	-0.65	12.2	0.37	0.37
Difference:	0.38 (0.34)	0.54 (0.42)	-6.95** (2.92)	0.43 (0.51)	0.42 (0.38)
Observations (intervention	67	67	66	66	66
Observations (total):	257	257	256	256	256

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Table 5.6b: Agricultural sales

	1	2	3	4	5
	Household sold any crops in the past 12 months (%)	**Number of crop types sold in the past 12 months**	**Total value of cereal crops sold in past 12 months (Cordobas)**	**Total value of all crops sold in past 12 months (Cordobas)**	**Total value of all crops sold in past 12 months (natural logarithm [Ln] of value in cordobas)**
Overall					
Intervention group mean:	47.8	1.06	3791.1	4570.9	4.05
Comparison group mean:	46.8	0.79	7303.8	8647.4	4.35
Difference:	1.00 (5.60)	0.27 (0.16)	-3512.8*** (1199.9)	-4076.4*** (1404.9)	-0.30 (0.52)
Observations (intervention group):	161	161	161	161	161
Observations (total):	482	482	482	482	482
Direct project participants					
Intervention group mean:	51.6	1.10	4697.6	5632.5	4.54
Comparison group mean:	51.5	0.82	8424.7	9808.1	4.78
Difference:	0.18 (7.27)	0.28 (0.18)	-3727.1* (1981.7)	-4175.6** (2123.3)	-0.25 (0.69)
Observations (intervention group):	91	91	91	91	91
Observations (total):	410	410	410	410	410
Other cooperative members					
Intervention group mean:	43.3	0.88	1838.1	2299.1	3.35
Comparison group mean:	39.8	0.74	5307.4	7268.4	3.66
Difference:	3.51 (7.97)	0.14 (0.28)	-3469.3*** (1243.3)	-4969.3*** (1899.7)	-0.31 (0.72)
Observations (intervention group):	67	67	67	67	67
Observations (total):	257	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

5.4 DIETARY DIVERSITY

The approach adopted to assess households' dietary situation was to ask directly about the types of food eaten by the household during the seven days prior to the survey. Respondents were presented with a list of 12 food types, and were asked on how many days of the previous seven days the food type had been eaten by the female respondent and any male household members.[7]

The results were used to create two different indicators of dietary diversity, the first being the number of different food types consumed by the respondent and any male household members in the previous seven days (columns 1 and 2). Secondly, a simple indicator was constructed to examine the difference in food types consumed by females and males within the household. Column 3 of Table 5.7 shows this indicator – although there is no clear evidence of a difference between project and comparison households.

The food consumption data was also used to construct an indicator of positive dietary diversity, defined as being positive for households (females and males separately [columns 4 and 5]) meeting all of these standards:

• Female/male members consumed a protein source (pulses, eggs, dairy products, meat or fish) on at least four of the previous seven days.

• Female/male members consumed green leafy vegetables on at least three of the previous seven days.

• Female/male members consumed other types of fruit and vegetables on at least three of the previous seven days.

Overall, 34 per cent of female respondents in project communities met this threshold, as well as 33 per cent of male members in the household. This compares to 16 and 18 per cent respectively for female and male members in comparison communities. These differences are significant for households of direct project participants and other cooperative members. Although the figures in columns 4and 5 suggest this difference is only significant for other cooperative members, other statistical models (not shown) suggest that the difference is also significant for the direct project participants.

Finally columns 6 to 8 examine the specific foods consumed by the female respondents. Column 6 shows the proportion of respondents who eat meat or fish at least twice a week; column 7 shows the proportion who eat vegetables at least three times a week; and column 8 the proportion who eat fruit at least three times a week. There is evidence that project respondents consume vegetables and fruit more regularly, although this appears to be restricted to other cooperative members (indirect beneficiaries) rather than direct project participants.

The results in Sections 5.3 and 5.4 may be linked. We saw in Section 5.3 that project participants produced a more diversified crop portfolio, but that crop sales either declined or remained unchanged. Thus, we may expect project participants to consume some of their diverse crop portfolio, and thus have more diversity in their diet especially in terms of vegetables and fruits, which they can grow themselves. These patterns are confirmed by the results in Section 5.4.

Table 5.7: Dietary diversity

	1	2	3	4	5	6	7	8
	Number of different food types consumed by the respondent in the past 7 days	Number of different food types consumed by men in the household in the past 7 days[8]	Difference between the number of food types consumed by the respondent and men in the household	Female respondents with positive food diversity %	Other male household members with positive food diversity %	Female respondents eating meat or fish at least twice a week %	Female respondents eating vegetables at least three times a week %	Female respondents eating fruits at least three times a week %
Overall								
Intervention group mean:	10.1	10.1	-0.021	34.2	33.1	0.86	0.54	0.53
Comparison group mean:	9.75	9.79	-0.011	16.3	18.3	0.83	0.39	0.36
Difference:	0.33* (0.18)	0.34* (0.18)	-0.017 (0.035)	17.8*** (4.87)	14.9*** (5.48)	0.024 (0.039)	0.15*** (0.056)	0.17*** (0.058)
Observations (intervention	161	142	142	161	142	161	161	161
Observations (total):	482	438	438	482	438	482	482	482
Direct project participants								
Intervention group mean:	9.98	10.1	-0.023	35.2	33.7	0.85	0.56	0.49
Comparison group mean:	9.80	9.92	-0.055	18.3	19.8	0.78	0.46	0.38
Difference:	0.18 (0.24)	0.14 (0.25)	0.039 (0.051)	16.9** (6.77)	13.9* (7.23)	0.064 (0.055)	0.10 (0.076)	0.11 (0.070)
Observations (intervention	91	86	86	91	86	91	91	91
Observations (total):	410	380	380	410	380	410	410	410
Other cooperative members								
Intervention group mean:	10.2	10.2	-0.019	36.4	35.8	0.85	0.56	0.55
Comparison group mean:	9.67	9.73	-0.0060	12.4	14.7	0.88	0.34	0.33
Difference:	0.48 (0.30)	0.37 (0.32)	-0.0087 (0.069)	23.9*** (7.56)	20.4** (9.40)	-0.035 (0.052)	0.22** (0.090)	0.21** (0.092)
Observations (intervention group):	66	53	53	66	53	66	66	66
Observations (total):	256	225	225	256	225	256	256	256

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1000 repetitions, with standard errors clustered by community.

5.5 INDICATORS OF MATERIAL WEALTH

Respondents were asked to provide information about their household's ownership of various assets (including livestock, productive equipment and household goods), as well as about the conditions of the family's house, both in 2010 and at the time of the survey. To provide an overall indication of each household's economic situation, this information on asset ownership and housing conditions was used to generate an index of household wealth.

If each of those assets and housing characteristics are indicators of household wealth, they should be correlated with each other. That is, a household that scores favourably on one particular wealth indicator should be more likely to do so for other wealth indicators. A small number of items that had low correlations with the others were therefore not considered to be good wealth indicators and so were excluded from the index.[9]

A data reduction technique called principal component analysis (PCA) was used to produce two indices of overall wealth, one based on the recalled data from 2010, and one based on the household's situation at the time of the survey. PCA produces a measure that maximises the variation in asset types by assigning more weight to those assets that are most highly correlated with the inter-item variation. Hence, each household's weighted index score is determined by both the number of assets it owns, and by the weight assigned to each asset type. The resulting index enables the relative wealth status of the households to be compared. The wealth index for 2010 is the measure that has been used throughout this analysis to control (to the greatest extent possible) for baseline differences in wealth status between households in the project and comparison communities.

After calculating the wealth index for both 2010 and the date of the survey, households were categorised according to the quintile in which they lie – that is, the top 20 per cent of households according to wealth indicators were categorised together, as were those in the next 20 per cent, and so on. The measure reported in Table 5.8 is based on households moving between quintiles. For example, a household that changed from being among the bottom 20 per cent of the sample in 2010 to being in the 20–40 per cent quintile (i.e. the second quintile) at the time of the survey would be given a score of +1. A household that moved from the middle quintile (3rd quintile) to the bottom quintile would have a score of -2.

As can be seen from Table 5.8 there have been only very small differences in the change of wealth status and there is no evidence of a difference between the project and comparison households. It is important to note that this links with one of the major learning points arising from this project. Namely, in order to affect 'higher level' outcomes like wealth, which typically take many years to change, we require better integration of projects, not just within Oxfam, but also with other NGOs operating in the area. As we discuss in Section 6, this reflects the logic of 'systems thinking'.

Table 5.8: Indices of wealth

	1
	Number of quintiles of wealth index in which household increased
Overall	
Intervention group mean:	0.0062
Comparison group mean:	-0.13
Difference:	0.14 (0.089)
Observations (intervention group):	161
Observations (total):	482
Direct project participants	
Intervention group mean:	-0.066
Comparison group mean:	-0.19
Difference:	0.12 (0.11)
Observations (intervention group):	91
Observations (total):	410
Other cooperative members	
Intervention group mean:	0.030
Comparison group mean:	-0.13
Difference:	0.16 (0.16)
Observations (intervention group):	67
Observations (total):	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

5.6 INDICATORS OF RESILIENCE

The project under review was specifically aimed at increasing households' resilience to crises. As part of Oxfam GB's Global Performance Framework, an innovative approach has been developed to measuring the resilience of households to shocks and stresses and their ability to adapt to change.[10] This approach involves capturing data on various household and community characteristics falling under the five interrelated dimensions presented in Figure 5.2.

One reason why measuring concepts such as resilience and adaptive capacity is challenging is that we can only really assess whether a system has successfully coped or adapted after the fact. In other words, we would have to wait until after a crisis has struck in order to assess the effectiveness of the intervention in question.

The characteristic approach to resilience measurement is based on the assumption that there are particular characteristics of households and communities that affect how well they are able to cope with shocks and positively adapt to change. A limitation, of course, is that we do not know for certain how relevant these characteristics actually are; rather, we assume they are important based on common sense, theory, and an understanding of the local context.
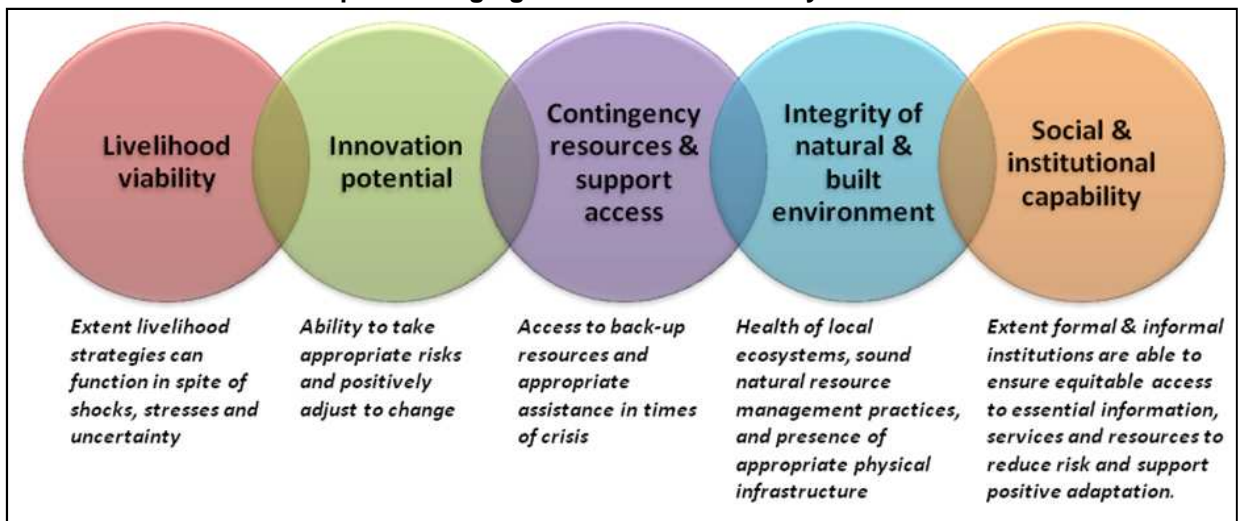
The characteristics that inform the overall measure of resilience fall under the five dimensions presented in Figure 5.2. First, if we think about what a household would need in order to cope with current and future shocks, stresses and uncertainty, a **viable livelihood** is likely to be one of them. If a shock happens, for instance, a

household dependent on just one precarious livelihood activity is likely to be more negatively affected than another that has one or more less sensitive alternatives to fall back on, *all other things being equal*. In addition, households that are on the margins of survival are less likely to be resilient than their relatively more wealthy counterparts. Where longer-term climatic trend prediction information exists, it is also important to assess how viable current livelihood strategies would be given the range of likely future climatic scenarios.

Innovation potential focuses on a household's ability to positively adjust to change, whether anticipated or not. We can hypothesise that such potential is dependent on factors such as the knowledge and attitudes of relevant household members themselves, their ability to take risks, and their access to weather prediction, market information and relevant technology and resources.

Figure 5.2: Dimensions affecting the ability of households and communities to minimise risks from shocks and adapt to emerging trends and uncertainty

Livelihood viability	Innovation potential	Contingency resources & support access	Integrity of natural & built environment	Social & institutional capability
Extent livelihood strategies can function in spite of shocks, stresses and uncertainty	Ability to take appropriate risks and positively adjust to change	Access to back-up resources and appropriate assistance in times of crisis	Health of local ecosystems, sound natural resource management practices, and presence of appropriate physical infrastructure	Extent formal & informal institutions are able to ensure equitable access to essential information, services and resources to reduce risk and support positive adaptation.

Moreover, there will likely be times when even households with the most resilient and adaptive livelihood strategies will find it tough to get by. **Access to contingency resources and external support** – e.g. savings, food and seed reserves, social protection, kin and non-kin support networks, emergency services – is, therefore, likely to be critical in supporting households in coping with shocks and positively adjusting to change.

It is further recognised that **healthy ecosystems** are better able to cope and adjust to climatic shocks/change than those that are relatively more degraded. We may reasonably assume – again, with all other things being equal – that households whose livelihoods are dependent on healthier ecosystems will be in a better position to adjust to climatic shocks/change than those that are not. The presence of appropriate infrastructure (e.g. pit latrines and roads) that is resilient to shocks and stresses (e.g. flooding) is equally important; if critical infrastructure no longer functions or collapses in times of shocks and stress, the livelihoods and/or health of community members can be negatively affected.

In most, if not all cases, it is necessary to look beyond the household level when examining resilience and adaptive capacity. Indeed, it is reasonable to assume that households are likely to be better able to successfully adjust to climatic shocks/change when they are part of larger, coordinated efforts at the community level and beyond. The **social and institutional capability** dimension, in particular, is concerned with the effectiveness of informal and formal institutions in reducing risk, supporting positive adaptation, and ensuring equitable access to essential services in times of shock/stress. In the absence of this capability, we can assume that community-level

duty-bearers will be less effective in fulfilling their responsibilities in supporting community members to reduce risk and/or successfully adapt.

There is no one generic set of 'resilience' characteristics that are applicable to all contexts. Given this, efforts were made to specify characteristics relevant to the specific risks faced in the area where the survey was carried out. The characteristics identified are listed in Table 5.9. It is important to note at this stage that while not all characteristics considered in this Effectiveness Review may be directly linked to the project activities, all are deemed to be important to a household's overall resilience in this particular context. The middle column of Table 5.9 shows those characteristics on which the project activities may be expected to have an impact.

Table 5.9: Characteristics of resilience examined in this Effectiveness Review

Dimension	Characteristic	Connected to project logic?	Positive and significant impact on:	
			Direct project participants?	Other cooperative members?
Livelihood viability	Land ownership	No	No	Yes
	Crop diversification	Yes	Yes	Yes
	Crop production	Yes	No	No
	Adoption of improved practices	Yes	Yes	Yes
	Access to markets	No	No	Yes
	Livelihood diversification	No	No	No
	Ownership of productive assets	No	Yes	No
Innovation potential	Understanding of climate change	Yes	Yes	No
	Adoption of new practices or initiatives	Yes	Yes	No
	Ability to influence others	Yes	Yes	No
	Access to credit	Yes	No	No
Access to contingency resources and support	Grain storage	Yes	No	No
	Savings	No	No	No
	Access to remittances or state support	No	No	No
Integrity of the natural and built environment	Location of house	No	No	No
	Access to safe drinking water	No	No	Yes
	Access to irrigation	No	No	No
	Tree planting	Yes	Yes	Yes
Social and institutional capability	Solidarity in the community	No	Yes	No
	Involvement in risk management and emergency preparedness committee	No	Yes	Yes
	Risk management plan	Yes	Yes	Yes
	Communal actions taken to mitigate risk	Yes	Yes	No
	Early-warning system	No	Yes	No

Indices of resilience were constructed using an approach known as the Alkire-Foster method, adapted from that used by the Oxford Poverty and Human Development Institute for measuring multidimensional constructs, such as poverty and women's empowerment.

The questionnaire used in the Effectiveness Review included questions relating to each of the characteristics listed in Table 5.9. Indeed, several of these indicators have already been discussed in earlier sections of this report. For each characteristic, a benchmark was defined based on what it means for a household to be faring reasonably well in relation to the characteristic in question. The particular benchmarks used for each characteristic are detailed in Appendix 1. For example, each household was defined as scoring positively in terms of crop diversification if the household farmed at least two different types crops. There is inevitably a degree of arbitrariness in defining such cut-offs. In many cases, alternative cut-offs and alternative formulations of the indicators were tested as a check on the robustness of the results obtained from applying the cut-offs.

A measure of overall resilience was then derived by counting the proportion of characteristics in which the household scored positively. We refer to this measure as the *base resilience index*. A household was then defined as having positive resilience overall if it scored positively in at least two thirds of the characteristics. A second resilience index was then created, which takes a value of 1 if the household reaches that benchmark for overall resilience and otherwise is equal to the proportion of characteristics in which the household scored positively. This modified index is known as the *Alkire-Foster resilience index*.[11] In fact in this case, over three-quarters of project households scored positively, so the Alkire-Foster index is little different from the base resilience index.

Table 5.10 presents the differences between the households surveyed in the project and comparison communities in terms of each of these three measures of overall resilience.

It is immediately apparent from Table 5.10 that there are significant differences between the intervention and comparison households in terms of their overall resilience scores, no matter which of the measures are used. For example, the base resilience index among intervention households is 0.54, showing that these households scored positively on average on 54 per cent of the characteristics. This is significantly higher than the average of the base resilience index among the matched comparison households, 0.45. These differences are also clear from the histogram in Figure 5.3, where the resilience scores in the project households (shown with the shaded bars) are distributed around higher values than those of the comparison households (shown with transparent bars).

Importantly, the differences in resilience index scores between the project and comparison households appear to be particularly concentrated among households of direct project participants; adding confidence in attributing these apparent increases in resilience to the effects of the project activities.

These results, then, provide evidence that the project has had a significant effect on overall household resilience, particularly among direct project participants. The following subsections will examine the results for the various characteristics that make up these overall results.

Table 5.10: Overall indices of resilience

	1	2
	Base resilience index	**AF resilience index**
Overall		
Intervention group mean:	0.54	0.77
Comparison group mean:	0.45	0.66
Difference:	0.089*** (0.019)	0.11*** (0.027)
Observations (intervention group):	161	161
Observations (total):	482	482
Direct project participants		
Intervention group mean:	0.58	0.83
Comparison group mean:	0.47	0.70
Difference:	0.11*** (0.022)	0.13*** (0.028)
Observations (intervention group):	91	91
Observations (total):	410	410
Other cooperative members		
Intervention group mean:	0.48	0.70
Comparison group mean:	0.42	0.62
Difference:	0.061** (0.031)	0.084** (0.041)
Observations (intervention group):	67	67
Observations (total):	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Figure 5.3: Histogram of base resilience index for intervention and comparison households
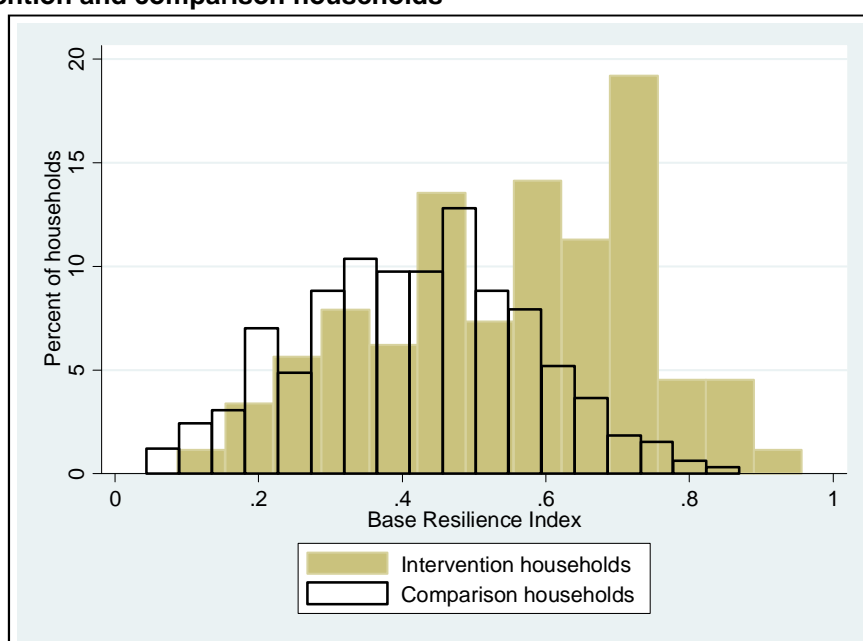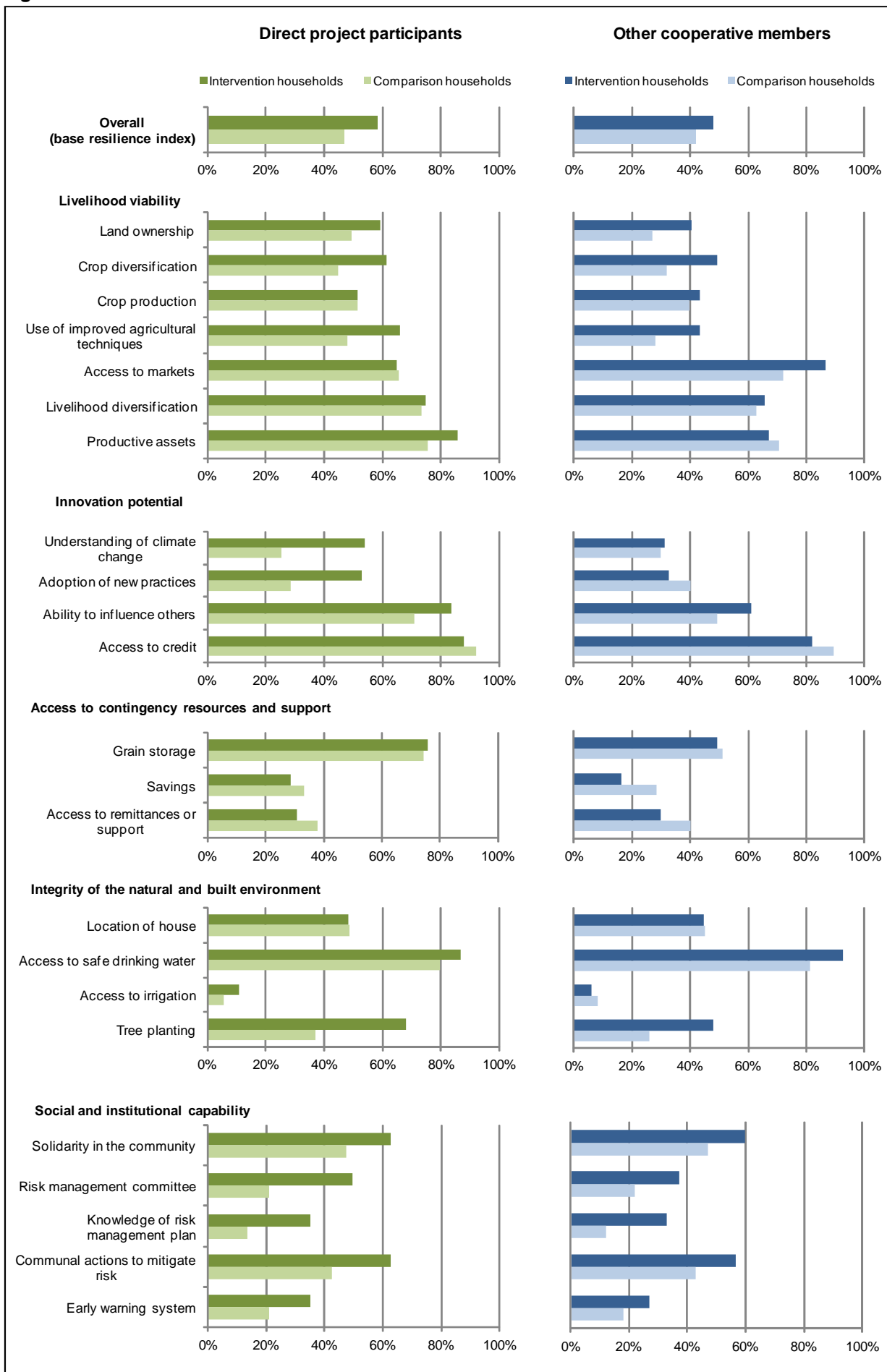
Figure 5.4: Results for characteristics of resilience

Dimension 1: Livelihood viability

The first dimension in the resilience framework presented in Figure 5.4 is livelihood viability. To what extent is there evidence that intervention households possess livelihoods that are more resilient to shocks than the comparison households? In other words, to what extent are they better off in relation to the characteristics assessed under the livelihood viability dimension? Seven characteristics of livelihood viability were considered in this Effectiveness Review. Table 5.12 shows the proportions of intervention and comparison households who scored positively in terms of each of these characteristics, according to the thresholds defined in Appendix 1.

The first indicators of the strength of households' resilience capacity are their **ownership of land** and **ownership of productive assets**. A household scored positively on the first indicator if it owned at least four manzanas of land. As can be seen in the first column of Table 5.11, there is tentative evidence that households of other cooperative members own more land than their comparators. For the ownership of assets measure, a simple indicator was constructed which was positive for any household that owned at least three large assets (including bulls, pigs, horses and a fridge, TV, satellite dish, oven, grinder, motorbike or other vehicle) or at least six small assets (including a radio, horse/ox cart, solar panel, bicycle or sprayer), or at least two large and four small assets. As can be seen in the final column of Table 5.11, there is also tentative evidence of a significant difference between households of direct project participants and their comparators.

The next three characteristics considered were all indicators of the household's agricultural activity. Firstly, households were considered to have positive **crop diversity** (column 2) if they had cultivated two or more types of crop in the 12 months prior to the survey. Just less than 56 per cent of project households met this criterion, and there is evidence to suggest greater crop diversity among these households.

Households were scored positively in terms of **crop production** (column 3) if they sold at least one of their crops, i.e. the household produced enough to be able to sell the surplus. Just less than half of the households in the project communities met this criterion, but no significant differences between these and households in the comparison communities were detected.

Households' agricultural activities were considered to be more resilient if they were applying the various **improved agricultural techniques** already discussed in Section 5.3. Households scored positively if they reported using at least four of these techniques. As has already been seen, a higher proportion of project households used many these techniques than comparison households. It is therefore not surprising that the indicator in this case (as shown in column 4 of Table 5.11) is also considerably higher – particularly in households of direct project participants.

For the **access to markets** indicator, a household scored positively if it took members less than 90 minutes to travel to the nearest town via their most usual modes of transport. Column 5 of Table 5.11 shows that almost three-quarters of households scored positively. A higher proportion of households of other cooperative members scored positively, and there were also significant differences between them and comparison households in this regard.

Households scored positively in terms of **livelihood diversity** (column 6) if they received income in the previous 12 months from at least three sources of livelihood activity. Just less than 70 per cent of project households scored positively, but there are no significant differences between the project and comparison communities.

Table 5.11: Households scoring positively in terms of characteristics of livelihood viability

	1 Land ownership %	2 Crop diversifica- tion %	3 Crop production %	4 Use of improved agricultural techniques %	5 Access to markets %	6 Livelihood diversification %	7 Productive assets %
Overall							
Intervention group mean:	52.2	55.9	47.8	55.9	73.9	69.6	78.3
Comparison group mean:	41.9	41.0	46.8	40.9	65.0	70.4	74.9
Difference:	10.3* (5.41)	14.9*** (5.49)	1.00 (5.60)	15.0*** (5.67)	8.87* (5.14)	-0.85 (5.17)	3.38 (4.51)
Observations (intervention group):	161	161	161	161	161	161	161
Observations (total):	482	482	482	482	482	482	482
Direct project participants							
Intervention group mean:	59.3	61.5	51.6	65.9	64.8	74.7	85.7
Comparison group mean:	49.4	44.9	51.5	47.9	65.4	73.5	75.4
Difference:	9.99 (7.11)	16.6** (7.50)	0.18 (7.27)	18.0** (7.11)	-0.55 (6.41)	1.19 (6.03)	10.3* (5.85)
Observations (intervention group):	91	91	91	91	91	91	91
Observations (total):	410	410	410	410	410	410	410
Other cooperative members							
Intervention group mean:	40.3	49.3	43.3	43.3	86.6	65.7	67.2
Comparison group mean:	26.9	32.1	39.8	28.0	72.1	62.8	70.8
Difference:	13.4* (7.81)	17.1** (8.39)	3.51 (7.97)	15.3* (8.40)	14.5** (6.91)	2.88 (8.64)	-3.66 (8.26)
Observations (intervention group):	67	67	67	67	67	67	67
Observations (total):	257	257	257	257	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1000 repetitions, with standard errors clustered by community.

Dimension 2: Innovation potential

Four characteristics of households' innovation potential were investigated in the survey and the results for these are summarised in Table 5.12. The first characteristic relates to **awareness of climate change** (column 1). For a household to score positively in this regard, the respondent had to be aware of the concept of climate change and mention at least three types of risk that climate change brings to their household. Just over 45 per cent of households from project communities scored positively, compared to 25 per cent of households from comparison communities. This difference is statistically significant, and is also significant for households of direct project participants. However, the difference between other cooperative members' households and comparison households is not significant.

Table 5.12: Households scoring positively in terms of characteristics of innovation potential

	1	2	3	4
	Understanding of climate change %	Adoption of new practices %	Ability to influence others %	Access to credit %
Overall				
Intervention group mean:	45.3	43.5	73.9	87.0
Comparison group mean:	24.9	31.5	65.5	90.2
Difference:	20.4*** (5.46)	12.0** (5.57)	8.46 (5.24)	-3.26 (3.36)
Observations (intervention group):	161	161	161	161
Observations (total):	482	482	482	482
Direct project participants				
Intervention group mean:	53.8	52.7	83.5	87.9
Comparison group mean:	25.3	28.7	70.7	92.0
Difference:	28.5*** (6.96)	24.0*** (7.22)	12.8** (6.01)	-4.08 (4.04)
Observations (intervention group):	91	91	91	91
Observations (total):	410	410	410	410
Other cooperative members				
Intervention group mean:	31.3	32.8	61.2	82.1
Comparison group mean:	29.8	40.1	49.2	89.4
Difference:	1.49 (8.23)	-7.28 (8.05)	12.0 (9.18)	-7.30 (6.28)
Observations (intervention group):	67	67	67	67
Observations (total):	257	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1000 repetitions, with standard errors clustered by community.

For households to score positively in the second characteristic – **adoption of new practices or initiatives** – they had to have implemented at least two of these, apart from those that were undertaken based on instruction or support from an NGO or project. Again, there is a large difference between project and comparison households, with a larger difference between households of direct project participants and their comparators. On average, direct project participants reported trying 1.8 new practices, compared to 1.1 among their comparators. However, there is no difference between households of other cooperative members and comparison households.

The third characteristic examines the respondent's **ability to influence others**. For this measure, households scored positively if respondents reported that they sometimes share knowledge of production techniques with other household members or with others in the community, and that these others have at least sometimes applied what they have told them. Again, there are positive significant differences between households of direct project participants and their comparators, although this difference is not large. This may be because it was only towards the ends of the project that these types of spillovers were emphasised. In addition it is interesting to note that a third of respondents (from both project and comparison households) reported that they **often** shared such knowledge with other household members, whereas a smaller proportion (25 per cent of project respondents) reported doing the same with other community members.

The final characteristic of households' innovation potential examined in the survey was **access to credit**. For this measure respondents were asked if they *would be able to* borrow 4,000 cordobas for an investment opportunity if they wanted to. Households scored positively on this characteristic if they could name at least one potential source from which they could borrow this sum. Almost 90 per cent of respondents said that they would be able to borrow this amount, but as shown in column 4 of Table 5.12, there is no indication of a difference between households in the project and comparison communities in this regard.

In summary, therefore, there is evidence of apparent positive change in three areas that were particularly important to the project; however, there is no evidence of a spillover of these effects to other cooperative members.

Dimension 3: Access to contingency resources and support

Three characteristics of households' access to contingency resources and support were considered in the questionnaire. The breakdown of results for each of these characteristics is shown in Table 5.13.

The first of the characteristics relates directly to one of the project activities – whether households had used **grain storage** in the previous 12 months. Over two-thirds of households scored positively in this regard, with a higher proportion among direct project participants. However, there are no significant differences between households from project and comparison communities, despite most of the project participants reporting that they had received metal silos from the project (as reported in section 5.2). It is important to note, however, that these results do not report on the quantity of seeds/grain that is stored, or the quality of the storage conditions.

The next two characteristics considered in this section – possession of **savings** and access to **remittances or state support** – are considered to be indicators of households' access to cash in times of crisis. Survey respondents were not asked directly for the value of the money they have saved, but were instead asked for how many days their household could live from its savings in an emergency. Those who reported that their household could manage from its savings for at least 30 days were deemed to have scored positively. Secondly, households were scored positively on the indicator for remittances and formal earnings if any household member reported that they sometimes receive remittances from outside the community or received financial support from the government. However, the results do not provide evidence of a difference between project and comparison households in terms of either of these characteristics.

Table 5.13: Households scoring positively on characteristics of access to contingency resources and support

	1	2	3
	Grain storage %	Savings %	Access to remittances/support %
Overall			
Intervention group mean:	64.6	27.3	29.2
Comparison group mean:	65.0	29.9	35.8
Difference:	-0.41 (5.30)	-2.59 (5.17)	-6.64 (5.36)
Observations (intervention group):	161	161	161
Observations (total):	482	482	482
Direct project participants			
Intervention group mean:	75.8	28.6	30.8
Comparison group mean:	74.3	33.1	38.0
Difference:	1.54 (5.95)	-4.50 (7.28)	-7.26 (6.48)
Observations (intervention group):	91	91	91
Observations (total):	410	410	410
Other cooperative members			
Intervention group mean:	49.3	16.4	29.9
Comparison group mean:	51.0	28.4	40.2
Difference:	-1.70 (9.25)	-12.0 (7.87)	-10.4 (8.78)
Observations (intervention group):	67	67	67
Observations (total):	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Dimension 4: Integrity of the natural and built environment

Results for the four characteristics of the integrity of the natural and built environment that were examined in the survey are shown in Table 5.14.

The first characteristic identified under this dimension was the **location of the house**. For a household to score positively, the house must not be located on low ground, in a floodplain, or on the side of a hill or volcano. Column 1 shows that overall 46 per cent of households in project communities met this criterion, and that there are no significant differences between the project and comparison communities.

The second characteristic relates to the household's **access to safe drinking water**. Those households reporting that their main source of water for drinking is a private well or municipal water supplies were deemed to have scored positively. There are significant positive differences in the proportion of households in the project and comparison communities scoring positively, but interestingly only among the households of other cooperative members.

The third characteristic identified was **access to irrigation**. For this measure, a household scored positively if some of its cultivated land is irrigated. As can be seen from column 3 in Table 5.14 only 9 per cent of households in project communities practise any irrigation. There are no significant differences between project households and the comparison households in this regard.

Table 5.14: Households scoring positively on characteristics of integrity of the natural and built environment

	1	2	3	4
	Location of house %	**Access to safe drinking water %**	**Access to irrigation %**	**Tree planting %**
Overall				
Intervention group mean:	46.0	89.4	9.32	59.0
Comparison group mean:	47.1	80.1	7.82	31.0
Difference:	-1.09 (5.54)	9.30** (3.86)	1.50 (3.54)	28.0*** (5.32)
Observations (intervention group):	161	161	161	161
Observations (total):	482	482	482	482
Direct project participants				
Intervention group mean:	48.4	86.8	11.0	68.1
Comparison group mean:	48.7	79.5	5.53	37.1
Difference:	-0.35 (7.29)	7.34 (5.26)	5.46 (4.07)	31.0*** (7.42)
Observations (intervention group):	91	91	91	91
Observations (total):	410	410	410	410
Other cooperative members				
Intervention group mean:	44.8	92.5	5.97	47.8
Comparison group mean:	45.1	81.2	8.27	26.0
Difference:	-0.30 (8.85)	11.4** (5.55)	-2.30 (5.48)	21.8*** (8.17)
Observations (intervention group):	67	67	67	67
Observations (total):	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

The final characteristic in this dimension relates to **tree planting**. For a household to score positively it must have planted at least 10 trees between 2012 and 2014, and as column 4 indicates, just less than 60 per cent of households in project communities met this benchmark. The proportion is higher for households of direct project participants and lower among households of other cooperative members, but all exhibit significant positive differences when compared with the comparison households. One way in which the project aimed to build understanding of climate change and encourage experimentation and adaptation in productive activities was by supporting reforestation, so this result is directly connected to the programme logic.

The questionnaire also asked respondents how many trees had been planted in 2010 and 2011 – and how many of these trees had survived. A median of 45 trees had been planted by project households (compared to 25 trees in comparison households). Of these, a median of 19 trees had survived until the time of the survey (compared to 15 trees in the comparison households). The most popular type of tree planted by project households was 'madero negro', with four other species also proving popular, namely; 'marango', 'cedro', 'caoba' and 'pochote'.

Dimension 5: Social and institutional capability

The first characteristic in this dimension concerns households' **solidarity in the community**. Households were scored positively if they had reported either providing support to others in the community or they themselves had received support from others in the previous 12 months. Column 1 of Table 5.15 shows that there are significant differences in the proportion of households in the project and comparison communities scoring positively.

Table 5.15: Households scoring positively on characteristics of social and institutional capability

	1	2	3	4	5
	Solidarity in the community %	Involvement in risk management committee %	Knowledge of risk management plan %	Communal actions taken to mitigate risk %	Early warning system %
Overall					
Intervention group mean:	59.6	43.5	32.3	59.0	31.1
Comparison group mean:	46.1	21.3	13.5	41.5	17.2
Difference:	13.6** (5.71)	22.2*** (5.20)	18.8*** (4.63)	17.6*** (5.48)	13.8*** (5.09)
Observations (intervention group):	161	161	161	161	161
Observations (total):	482	482	482	482	482
Direct project participants					
Intervention group mean:	62.6	49.5	35.2	62.6	35.2
Comparison group mean:	47.5	21.0	13.5	42.6	20.8
Difference:	15.2** (7.51)	28.5*** (6.62)	21.7*** (6.09)	20.1*** (7.24)	14.4* (7.42)
Observations (intervention group):	91	91	91	91	91
Observations (total):	410	410	410	410	410
Other cooperative members					
Intervention group mean:	59.7	37.3	32.8	56.7	26.9
Comparison group mean:	47.0	22.1	12.2	42.9	18.1
Difference:	12.7 (8.60)	15.3* (7.94)	20.6*** (7.16)	13.8 (9.00)	8.75 (8.26)
Observations (intervention group):	67	67	67	67	67
Observations (total):	257	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

The second characteristic examines households' **involvement in a risk management and emergency preparedness committee**. A household scored positively for this indicator if the respondent was aware of the existence of a risk management and emergency preparedness committee within the community, and some household member had attended a meeting during the previous six months. As can be seen in

column 2 of Table 5.16, there are large differences between the project and comparison households in this regard. Although the differences are smaller there is evidence to suggest that involvement in risk management plans increased for other members of cooperative that were not directly involved in the project (indirect beneficiaries). The effects on the indirect beneficiaries indicate that the emphasis on spillovers brought into the project towards its completion were somewhat successful. However, the spillovers may have been in larger, had there been more emphasis on sharing knowledge and influencing others during the project's design and early implementation phase.

There are also large differences between the project and comparison households in terms of the respondent being aware of the community's **risk management plan** (column 3).

The fourth characteristic concerns **communal actions taken to mitigate risk** in the community. Households scored positively if the respondent was aware of at least two types of activity that have been carried out in the community to mitigate risk during the previous 12 months. Again there are positive differences between project and comparison households, although in this case the difference is only significant among households of direct project participants.

The final characteristic examines whether respondents were aware that an **early-warning system** exists within the community, are reasonably confident that they would receive warning in advance of a natural disaster, and are at least partly aware of what they should do if they were to receive such a warning. Approximately one-third of project households scored positively in this regard, with significant differences between project and comparison households only found among households of direct project participants.

Which dimensions matter?

To what extent do each of the five dimensions drive the overall results for the resilience index? To answer this question, we construct an index for each dimension, which counts the proportion of characteristics in which the household scores positively in that dimension. That is, we take the average of all the indicators within each dimension. These results are shown in Table 5.16, and then drawn in spider charts for the direct project participants and the other cooperative members (indirect beneficiaries) in Figures 5.5a and 5.5b respectively.

Table 5.16: Household indexes of resilience for each dimension

	1	2	3	4	5
	Index of livelihood viability	Index of innovation potential	Index of access to contingency resources and support access	Index of integrity of natural and built environment	Index of social and institutional capability
Overall					
Intervention group mean:	0.62	0.62	0.40	0.51	0.45
Comparison group mean:	0.54	0.53	0.44	0.41	0.28
Difference:	0.075*** (0.025)	0.094*** (0.032)	-0.032 (0.031)	0.094*** (0.023)	0.17*** (0.036)
Observations (intervention group):	161	161	161	161	161
Observations (total):	482	482	482	482	482
Direct project participants					
Intervention group mean:	0.66	0.70	0.45	0.54	0.49
Comparison group mean:	0.58	0.54	0.48	0.43	0.29
Difference:	0.080*** (0.031)	0.15*** (0.035)	-0.034 (0.038)	0.11*** (0.030)	0.20*** (0.045)
Observations (intervention group):	91	91	91	91	91
Observations (total):	410	410	410	410	410
Other cooperative members					
Intervention group mean:	0.57	0.52	0.32	0.48	0.43
Comparison group mean:	0.47	0.52	0.40	0.40	0.28
Difference:	0.090** (0.044)	-0.0028 (0.045)	-0.080 (0.057)	0.076** (0.033)	0.14*** (0.053)
Observations (intervention group):	67	67	67	67	67
Observations (total):	257	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Figure 5.5a: Indexes of resilience for direct project participants
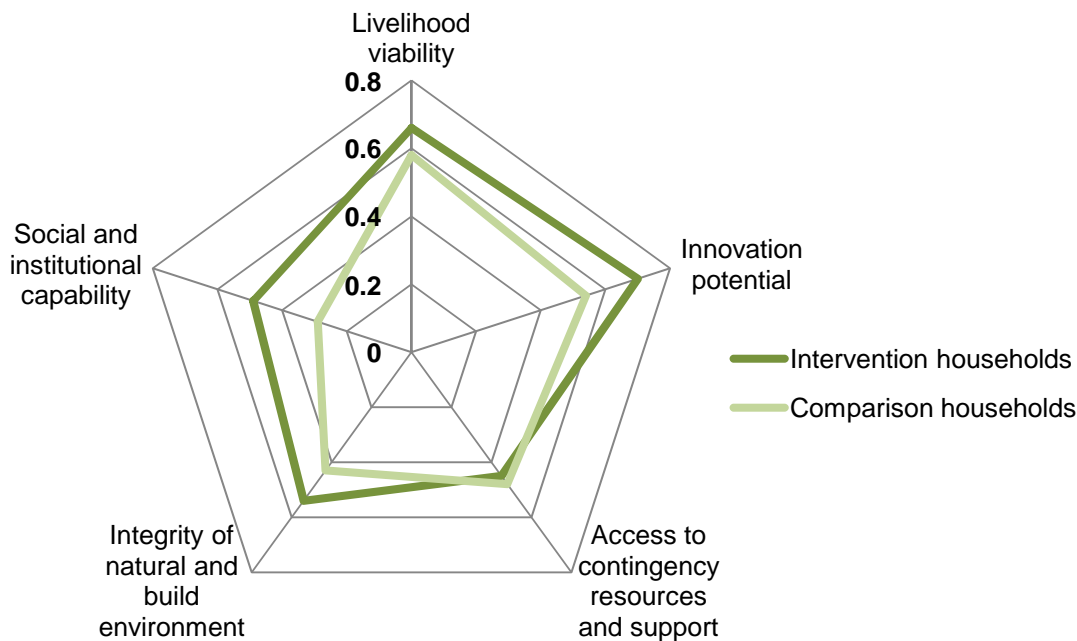
Figure 5.5a: Indexes of resilience for other cooperative members (indirect beneficiaries)
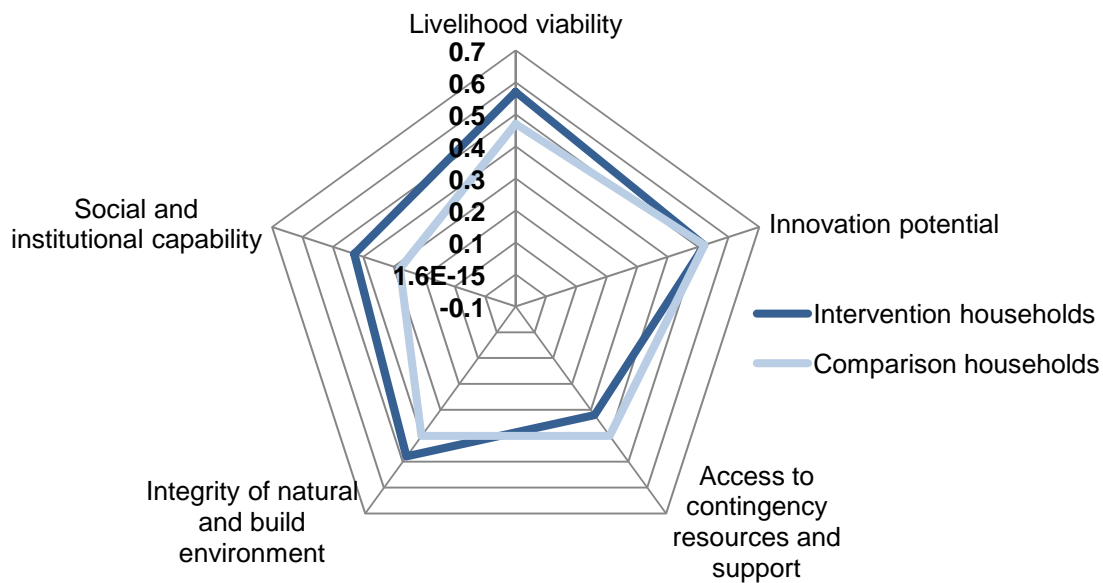
For both direct project participants there are positive and statistically significant increases among all dimensions of resilience, except for access to contingency resources and support. These positive effects spill over to the other members of the cooperatives (the indirect beneficiaries) except for in innovation potential. Although the project had most impact on the dimension of social and institutional capability, the increase in the overall resilience index (see Table 5.10) seems to have been driven by a number of dimensions, suggesting that the project was able to change a many different aspects of resilience.

5.6 INDICATORS OF WOMEN'S EMPOWERMENT

We turn now to consider how the project may have impacted upon different aspects of women's empowerment. Although the main aims of the project were related to resilience, it is useful to conduct an exploratory analysis to see if the project also had any unanticipated effects on women's empowerment. Indeed, there were some specific areas where it was hoped the project would have an effect. For example, women were encouraged to be more actively involved in the cooperatives and to take a greater role in leadership and the decision-making processes. At a household level, it was hoped that the project would also result in women being more involved in decision-making and making a greater contribution to household income.

The indicators of women's empowerment included in this section focus mainly on women's *economic* empowerment as these can be measured more straightforwardly in household questionnaires. However, we recognise that there may be *social* and *political* aspects of women's empowerment that our evaluation approach cannot capture. Thus, the results in this section do not necessarily tell the whole story.

It is important to note at the outset that because the project participants were self-selected to some extent, there is potential for unobserved bias. To try and counteract any potential bias, respondents' baseline membership of the cooperative was included as a matching variable.

Agricultural work and land ownership

The first aspect to consider is respondents' ownership of land. Column 3 of Table 5.17 shows that 57 per cent of respondents in project households reported personally owning some land, with the proportion slightly lower among direct project participants and slightly higher for other cooperative members. In all cases, however, there are no differences between the project participants and the respective comparison respondents.

Similarly, there are no positive differences in the proportion of project respondents reporting that they visit their household's land or personally work on the land.

Table 5.17: Respondents' involvement in agricultural work and land ownership

	1 Respondent knows the household's land %	2 Respondent works on the household's land %	3 Respondent personally owns land %
Overall			
Intervention group mean:	67.7	55.9	57.1
Comparison group mean:	64.0	51.6	49.9
Difference:	3.73 (5.39)	4.32 (5.69)	7.23 (5.47)
Observations (intervention group):	161	161	161
Observations (total):	482	482	482
Direct project participants			
Intervention group mean:	75.8	64.8	53.8
Comparison group mean:	70.8	57.5	49.6
Difference:	5.00 (6.88)	7.29 (7.17)	4.25 (7.05)
Observations (intervention group):	91	91	91
Observations (total):	410	410	410
Other cooperative members			
Intervention group mean:	56.7	46.3	58.2
Comparison group mean:	50.6	35.7	50.6
Difference:	6.11 (8.03)	10.6 (8.42)	7.64 (8.88)
Observations (intervention group):	67	67	67
Observations (total):	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Financial involvement and house ownership

A second aspect of women's empowerment is related to respondents' financial involvement in their households. Column 1 of Table 5.18 presents the proportion of household income that respondents directly contribute. Among project households, respondents contribute on average 41 per cent of household income. Further, the results suggest that respondents from households of other cooperative members contribute more than respondents who are direct project participants, but there are no significant differences between project and comparison households in this regard. Similarly when changes in the contribution of respondents between 2010 and the time of the survey are examined, no significant differences between project and comparison households are detected.

Column 2 of Table 5.18 shows that almost 80 per cent of respondents from project households report at least jointly owning their house. There is no evidence of significant differences between project and comparison households in this regard. Similarly there are no significant differences between the project and comparison households in the proportion of respondents who have personal savings of at least 4,000 cordobas.

Table 5.18: Respondents' financial involvement and house ownership

	1 Respondent's contribution to household income %	2 Respondent owns their house %	3 Respondent has personal savings of at least 4,000 cordobas %
Overall			
Intervention group mean:	41.3	78.3	16.1
Comparison group mean:	37.8	74.5	17.4
Difference:	3.47 (3.40)	3.72 (5.11)	-1.24 (4.50)
Observations (intervention group):	161	161	161
Observations (total):	482	482	482
Direct project participants			
Intervention group mean:	36.6	73.6	17.6
Comparison group mean:	39.4	74.8	19.8
Difference:	-2.83 (4.37)	-1.13 (6.43)	-2.23 (6.07)
Observations (intervention group):	91	91	91
Observations (total):	410	410	410
Other cooperative members			
Intervention group mean:	45.4	82.1	10.4
Comparison group mean:	37.5	73.2	15.6
Difference:	7.93 (5.66)	8.91 (8.12)	-5.10 (6.58)
Observations (intervention group):	67	67	67
Observations (total):	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Decision making

During the survey, questions were also asked about respondents' involvement in household decision-making. As we noted above, this is one specific area of women's empowerment that the project tried to change. Table 5.19 presents the results on several measures of household decision-making. Columns 1 and 2 examine the proportion of decision making areas in which respondents either had at least joint decision-making power (column 1) or had sole decision-making power (column 2). For respondents to score positively on the 'joint decision-making' measure they have to report that they make the decision jointly *and* if they disagree with the decision, they would have a 'lot of influence' in seeking a change of decision.

The range of decision-making areas is detailed in Figure 5.6. This means that Figure 5.6 disaggregates the information in column 1 of Table 5.19. Respondents from project households have at least joint decision-making power in 67 per cent of the 13 decision-making areas considered in the survey; however there are no significant differences between the project and comparison households. Figure 5.6 illustrates that the areas in which the respondent has least decision-making power appear to be in decisions related to the types of crops cultivated by the household and how to manage non-agricultural productive activities. However, when each of the decision-making areas are looked at in turn, there is evidence of significant positive differences between the project and comparison respondents in terms of decisions related to the to the types of crops cultivated by the household – but only among direct project participants.

Table 5.19: Household decision-making

	1 Decision-making areas where respondent at least jointly makes decision %	2 Decision-making areas where respondent solely makes decision %	3 Respondent offers opinion on farming activities %	4 Respondent can spend money in market without asking partner/other hh member %	5 Respondent makes at least joint decisions on household finances %
Overall					
Intervention group mean:	67.3	54.3	80.7	78.9	89.4
Comparison group mean:	68.7	55.8	71.7	80.9	89.1
Difference:	-1.37 (3.69)	-1.58 (3.56)	9.04* (4.86)	-2.01 (4.15)	0.38 (3.24)
Observations (intervention group):	160	160	161	161	161
Observations (total):	481	481	482	482	482
Direct project participants					
Intervention group mean:	64.2	47.5	86.8	76.9	90.1
Comparison group mean:	66.1	53.3	76.0	79.5	89.2
Difference:	-1.85 (4.38)	-5.88 (4.36)	10.8** (4.96)	-2.61 (5.57)	0.90 (3.85)
Observations (intervention group):	91	91	91	91	91
Observations (total):	410	410	410	410	410
Other cooperative members					
Intervention group mean:	70.8	62.8	73.1	82.1	88.1
Comparison group mean:	73.8	62.3	63.2	80.5	87.5
Difference:	-3.00 (4.72)	0.50 (6.08)	9.96 (7.83)	1.54 (7.35)	0.58 (6.79)
Observations (intervention group):	66	66	67	67	67
Observations (total):	256	256	257	257	257

Standard errors in parentheses; * p<0.1, ** p<0.05, *** p<0.01; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

There is also evidence of a positive difference between direct project participants and their comparators in terms of whether the respondent actively offers their opinion on farming activities (column 3), with 87 per cent of direct project participants actively doing this compared to 76 per cent of comparison respondents.

The final two columns of Table 5.18 consider two areas of financial decision-making – firstly whether respondents can spend money in the market without having to ask their partner or other household member for permission, and secondly whether respondents have at least joint decision-making power on other financial decisions within the household. In both indicators the proportion of respondents responding positively is

very high, but there are no significant differences between the project and comparison respondents.

Figure 5.6: Proportion of households where the respondent at least jointly makes decision, by decision-making area
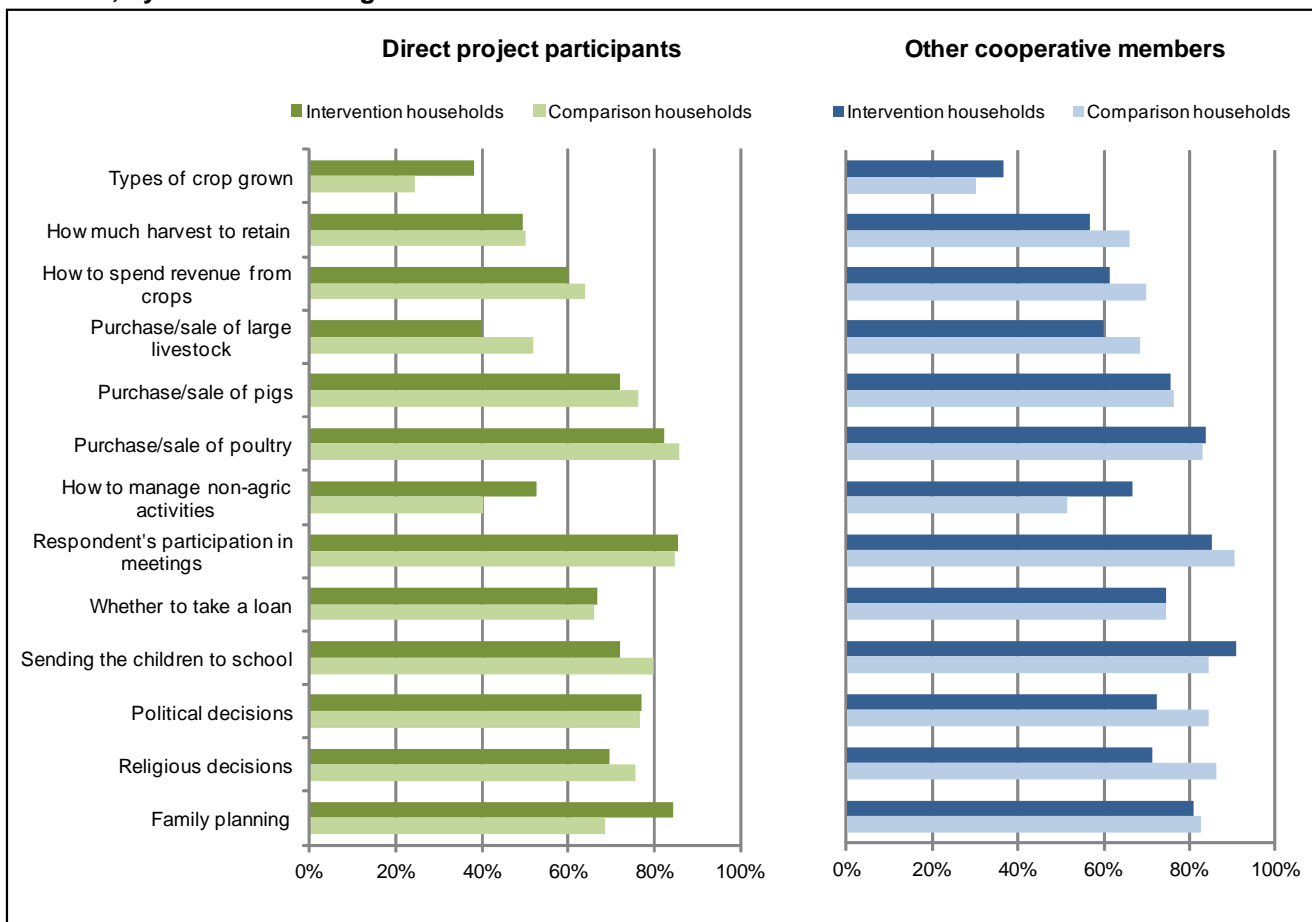
Thus, overall, the project appears to have empowered women to better influence decisions about crop cultivation and other farming activities, but there are no significant differences between project participants and comparison households for spending and other financial decisions.

Work in the household and time use

Figure 5.7 presents the proportion of work in the household that is done by either the respondent or other women in the household. In the survey, the respondents were asked for an estimate of this proportion for seven different areas of work within the household. It is clear from the results that project and comparison households are very similar in terms of the breakdown of responsibilities within the household.

Figure 5.7: Percentage of work in the household carried out by the respondent/other women in the household
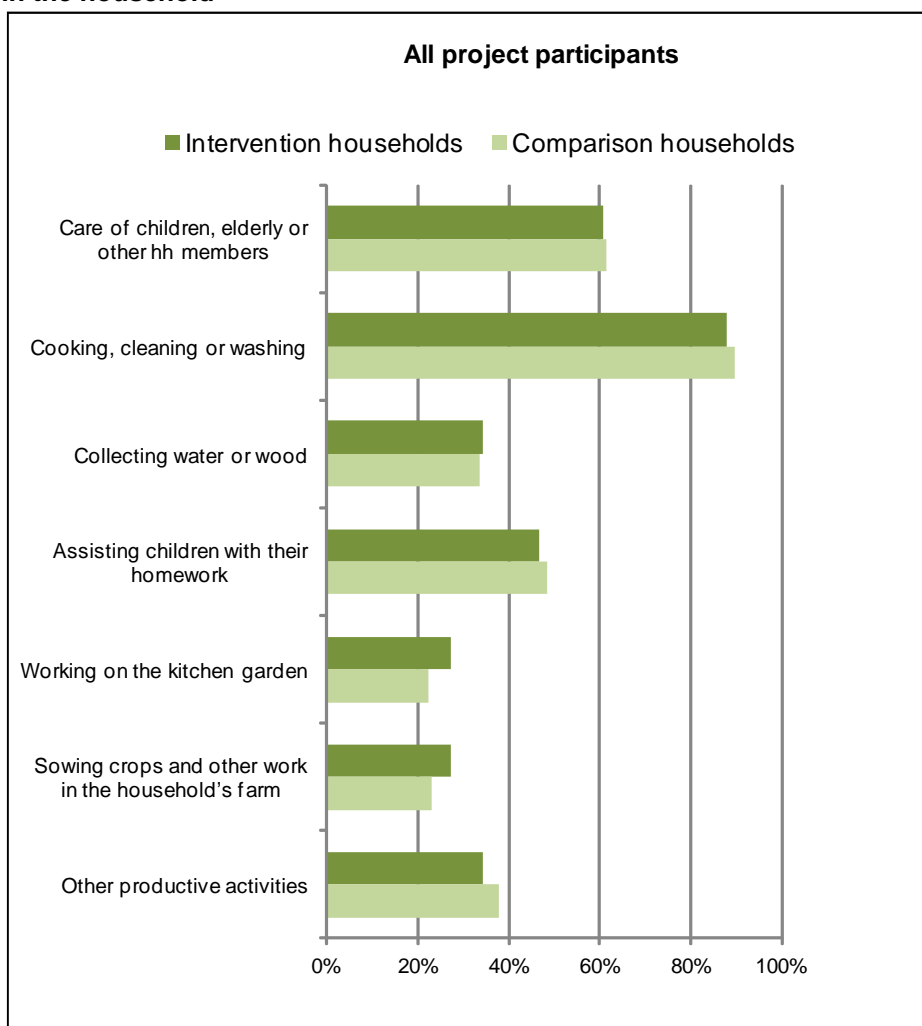
Tables 5.21 and 5.22 present the change in time dedicated to various activities by women in the households. In the questionnaire, respondents were only able to report whether the time devoted to each activity had increased, decreased, or stayed the same, so we cannot know exactly how they spent their time. The respondents were allocated a score of 1 if the time they dedicated to a particular activity had increased since 2010; a score of 0 if there was no change since 2010; and a score of -1 if the time spent on the activity had decreased since 2010. The figures in Tables 5.21 and 5.22 are therefore the averages of these scores across the respondents for the 13 activities covered in the survey. As can be seen from the tables, the results for the project and comparison respondents are very similar. There is only tentative evidence of a difference in the change of time dedicated to rest during the day – where the increase in rest time among comparison women is greater than for women who are direct project participants. However, this result is only supported by one of the other regression models, so the evidence is not conclusive.

 Figure 5.8 presents the proportion of respondents reporting an increase/decrease in time dedicated to the activities, using the same information from Tables 5.21 and 5.22 for the direct project participants and the other cooperative members taken together. The green bars show the project participants, while the thick black outlined bars show the comparison households. To the left of the central axis, we see the proportion of respondents who decreased their time use on that activity since 2010, and to the right, we see the proportion of households who increased their time use on that activity since 2010. The main message of Figure 5.8 echoes what we see in Table 5.21 and 5.22 –

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overall, there are very few significant differences between the project participants and the comparison households in terms of changing time use.

Figure 5.8: Proportion of households where the respondent reported an increase/decrease in time dedicated to various activities since 2010
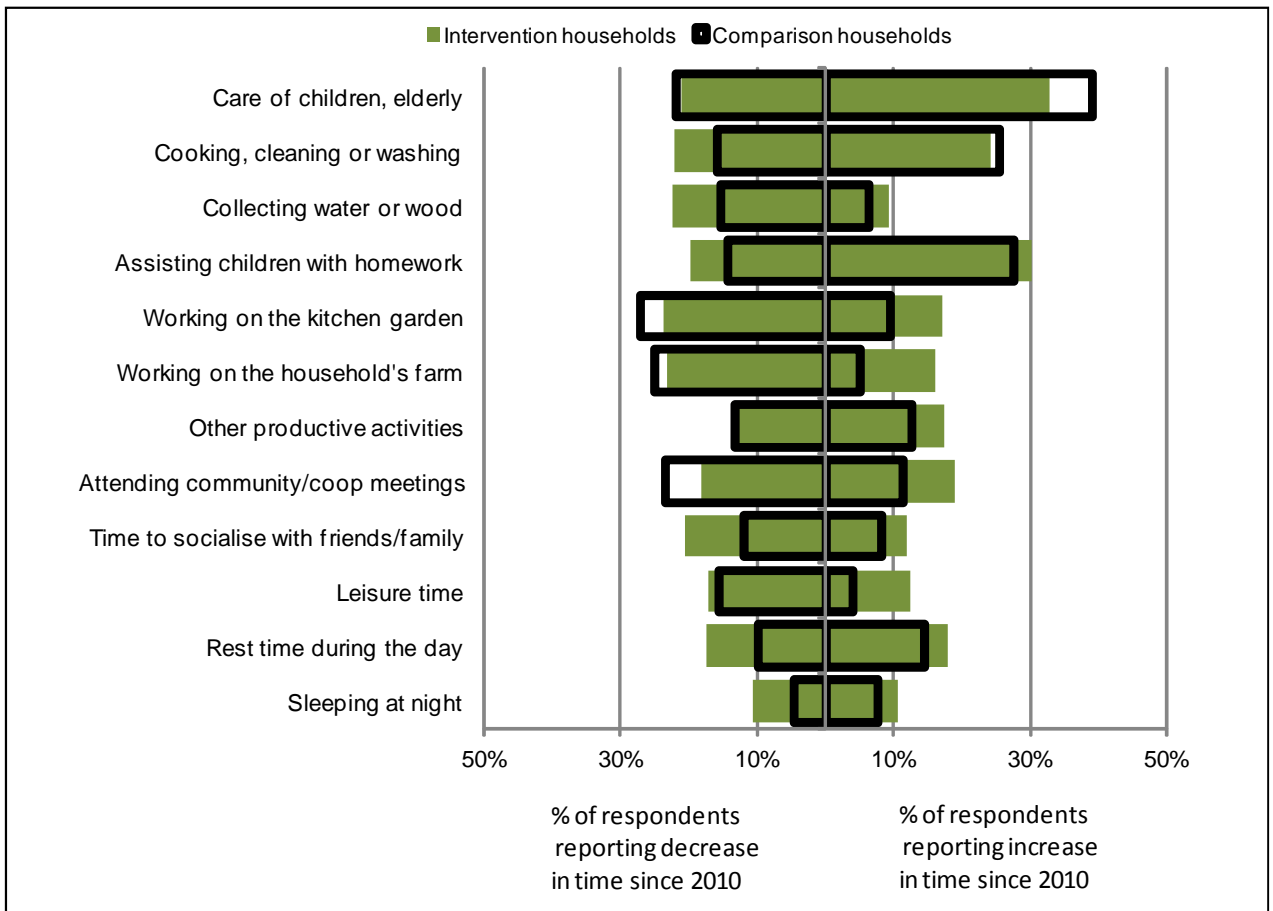
Table 5.21: Change in time dedicated by the respondent to different activities since 2010

	1 Care of children, elderly or other hh members	2 Cooking, cleaning or washing	3 Collecting water or wood	4 Assisting children with their homework	5 Working on the kitchen garden	6 Sowing crops and other work in the household's farm
Overall						
Intervention group mean:	0.12	0.019	-0.13	0.10	-0.065	-0.068
Comparison group mean:	0.17	0.097	-0.088	0.13	-0.18	-0.20
Difference:	-0.028 (0.10)	-0.078 (0.079)	-0.048 (0.065)	-0.0049 (0.10)	0.082 (0.11)	0.13 (0.085)
Observations (intervention group):	119	158	129	96	93	117
Observations (total):	369	478	400	312	216	340
Direct project participants						
Intervention group mean:	0.11	0.056	-0.069	0.13	-0.15	-0.071
Comparison group mean:	0.11	0.047	-0.10	-0.023	-0.23	-0.14
Difference:	0.032 (0.13)	0.0076 (0.10)	0.040 (0.085)	0.15 (0.12)	0.10 (0.12)	0.057 (0.090)
Observations (intervention group):	71	90	72	52	60	70
Observations (total):	320	408	342	269	185	293
Other cooperative members						
Intervention group mean:	0.14	-0.063	-0.19	0.050	0	-0.11
Comparison group mean:	0.25	0.17	-0.036	0.22	-0.046	-0.21
Difference:	-0.100 (0.17)	-0.23* (0.12)	-0.14 (0.11)	-0.15 (0.15)	0.048 (0.18)	0.071 (0.13)
Observations (intervention group):	44	64	58	40	32	45
Observations (total):	182	254	212	160	96	161

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Table 5.22: Change in time dedicated by the respondent to different activities since 2010 – continued

	1	2	3	4	5	6
	Other productive activities	Attending meetings of the coop/ other comm. group	Time to socialise with friends/ relatives	Leisure time	Rest time during the day	Sleeping at night
Overall						
Intervention group mean:	0.041	0.0068	-0.086	-0.048	0.0064	0
Comparison group mean:	-0.0059	-0.12	-0.037	-0.12	0.046	0.032
Difference:	0.013 (0.077)	0.13* (0.070)	-0.048 (0.058)	0.066 (0.056)	-0.041 (0.068)	-0.031 (0.049)
Observations (intervention group):	97	148	151	145	156	160
Observations (total):	301	456	460	447	476	481
Direct project participants						
Intervention group mean:	-0.053	-0.059	-0.081	-0.098	-0.023	-0.011
Comparison group mean:	-0.028	-0.17	-0.0052	-0.095	0.13	0.036
Difference:	-0.018 (0.079)	0.11 (0.085)	-0.079 (0.080)	0.014 (0.077)	-0.16* (0.087)	-0.047 (0.072)
Observations (intervention group):	57	85	86	82	86	90
Observations (total):	260	393	393	382	404	409
Other cooperative members						
Intervention group mean:	0.075	0.034	-0.15	-0.033	0.076	0
Comparison group mean:	0.10	-0.12	-0.0028	-0.11	0.013	0.055
Difference:	0.016 (0.13)	0.14 (0.097)	-0.15 (0.090)	0.072 (0.098)	0.063 (0.12)	-0.055 (0.076)
Observations (intervention group):	40	58	61	60	66	66
Observations (total):	166	237	243	237	255	256

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

Relationship with the community

The final aspect of women's empowerment considered in the survey is the respondents' relationship with the community. Table 5.23 examines four indicators related to this, and it is clear from the results that both project and comparison respondents score highly in each of the indicators. There are no significant differences between the project and comparison respondents in the first three indicators (columns 1 to 3 of Table 5.23), however column 4 shows that there is a positive difference between direct project participants and their comparators in whether the respondent reports that if a woman wants to express her opinions in a community group, people will let her do so.

Table 5.23: Respondents' relationship with the community

	1	2	3	4
	Respondent able to negotiate time to participate in community/ cooperative affairs %	Respondent reports that opinions of women in community meetings should always be taken into account %	Respondent reports that women now participate more actively in community affairs %	Respondent reports that if a woman wants to express her opinions in a community group, people will let her do so %
Overall				
Intervention group mean:	76.4	96.3	96.3	97.5
Comparison group mean:	75.2	96.2	95.7	90.7
Difference:	1.15 (4.79)	0.045 (2.19)	0.61 (2.04)	6.86** (2.82)
Observations (intervention group):	161	161	161	161
Observations (total):	482	482	482	482
Direct project participants				
Intervention group mean:	78.0	95.6	96.7	97.8
Comparison group mean:	76.8	97.1	94.4	91.7
Difference:	1.26 (6.65)	-1.51 (2.56)	2.25 (2.50)	6.14* (3.39)
Observations (intervention group):	91	91	91	91
Observations (total):	410	410	410	410
Other cooperative members				
Intervention group mean:	71.6	97.0	97.0	97.0
Comparison group mean:	66.2	97.4	97.9	90.1
Difference:	5.45 (9.11)	-0.42 (2.52)	-0.91 (2.27)	6.89 (4.80)
Observations (intervention group):	67	67	67	67
Observations (total):	257	257	257	257

Standard errors in parentheses; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; PSM estimates are bootstrapped with 1,000 repetitions, with standard errors clustered by community.

6 CONCLUSIONS

6.1 CONCLUSIONS

This Effectiveness Review found that the 'Climate change adaptation among small scale producers' project has positively affected resilience, as well as households' agricultural activities and dietary diversity in communities in the department of Chinandega. The project worked directly with 120 members of seven cooperatives, providing training and inputs for agriculture, building understanding of climate change, and supporting committees to manage risk. Towards the end of the project, extra emphasis was placed on trying to share the knowledge and resources to other cooperative members and the community at large. As such, the intervention group for this Effectiveness Review included not only the direct project participants, but also other members of the same cooperatives (indirect beneficiaries), to find out whether these types of spillovers had occurred.

Starting with the main impacts on resilience, even after controlling for apparent baseline differences between the intervention and comparison households, the direct beneficiaries scored positively on 58 per cent of the indicators identified as being important for resilience, compared to 47 per cent in the comparison households. Although the differences are smaller, there are also positive effects for the other cooperative members, who scored positively in 48 per cent of the resilience indicators compared to 42 per cent for their comparison group. This suggests not only that the project had a large and statistically significant effect on the overall resilience of direct project participants, but that there also important spillover effects to the indirect beneficiaries.

We are able to unpack the overall resilience index by disaggregating the results into each of the five dimensions, to see what is driving the positive impacts of the project. It emerges that, for the direct project participants, four out of the five resilience dimensions display positive and significant increases resulting from the project. It is only the access to contingency resources and support dimension that showed no change. For the other cooperative members, there were positive and significant increases for three out of the five dimensions. In spite of the strong effects on the direct project participants in terms of innovation potential, there were no spillovers for this dimension. Thus, the changes in the resilience index brought about by the project were driven by a number of different types of resilience indicator.

We can disaggregate the resilience index even more, by looking at each of the 23 characteristics separately to further examine how these overall increases in resilience were achieved. As shown in Table 5.9, there were positive and significant changes for 12 out of the 23 indicators for the direct project participants, while for the other cooperative members, eight of the indicators increased significantly.

One overarching point from this analysis is that the largest differences between the intervention and comparison households are connected to more 'output-related' characteristics, that is, indicators that are directly related to the project logic. This includes, for example, indicators of crop diversification, tree planting, and establishing risk management plans. However, there was generally less evidence that 'higher level' outcome measures of resilience, such as livelihood diversification, access to credit, and savings, were affected by the project. This is further reflected in the results for material wealth, where there were no significant differences between the intervention and comparison groups.

Moving back along the causal chain, this Effectiveness Review also allowed us to evaluate the project's direct impact on agricultural activities and dietary diversity. The project increased households' use of kitchen gardens and forest pasture land, as well as supporting the use of organic fertilisers and crop rotation and mulching, but many of these improvements were restricted to the direct project participants. Correspondingly, intervention households had a more diversified crop portfolio than those in the comparison group, although this resulted because the reduction in diversification across the survey area was dampened. Again, these effects only emerged for the direct project participants. The higher levels of crop diversification among intervention group households appears to have resulted in greater dietary diversity. There were no clear positive changes in total crop sales, suggesting that production was being reserved for the household. Moreover, consumption of fruit and vegetables was higher in the intervention group, especially for the other cooperative members (indirect beneficiaries).

Even though the project was focused on resilience, we also conducted an exploratory analysis of women's empowerment outcomes, since the project had some specific objectives related to women's involvement in cooperatives and decision making. Although there was evidence of some modest increases in women's involvement in decision making, especially with regard to agricultural activities, these effects were only seen for the direct project participants. Moreover, there was no evidence that the project had any effect on many other indicators of women's empowerment, including land ownership, involvement in financial decisions, and time use.

Overall, therefore, the project had a large, positive, and statistically significant impact on a number of important aspects of resilience. Vitally, the results were driven by indicators taken from across the five dimensions. However, the main effects were on measures of resilience that were directly related to the project activities, while higher level outcomes showed less evidence of change. The evidence is also mixed when it comes to spillovers onto the other members of the cooperatives, which were far larger for components of livelihood viability and social and institutional capability than for innovation potential.

6.2 LEARNING CONSIDERATIONS

While the findings of the Effectiveness Review are largely positive, there are additional lessons emerging from the results that can be applied to other projects of this type in Nicaragua and elsewhere. Through discussion with the country and project teams, and with input from partner staff, we are able to generate the following learning considerations:

Increase the emphasis on spillovers during the project design phase.

The project tried to create spillovers to other cooperative members and the community at large by training some participants as local promoters, who could pass on knowledge and establish demonstration plots on their land. Anecdotal evidence also suggests that project participants shared seeds and crops. However, this emphasis on spillovers was only brought in to the project towards the end of its implementation, and was not explicitly part of the design phase. This may explain why the results on spillovers are somewhat mixed. In particular, there is no evidence of spillovers on the dimension of innovation potential, where we hope to see understanding of climate change and new techniques permeating from the direct project participants through the cooperatives. It is therefore recommended that, in order to have more profound effects on other cooperative members besides the direct project participants, it is necessary to make spillovers part of project design.

Take a more integrated approach, taking account of other actors working in the area.

Although the project had a positive overall effect on the resilience index, there was less evidence that higher-level outcomes, including wealth, were changed. In order to affect these types of outcomes, we may require better integration of projects like 'Climate change adaptation among small scale producers' with other activities being undertaken not only by Oxfam, but also by other NGOs in the area. This reflects a 'systems thinking' approach that takes into account and incorporates all the relevant actors and how they are linked during the design of the programme. This type of approach may also be supported by a monitoring and evaluation framework, which gives project staff information about changes in the system in a frequent and timely way.

Consider further research to investigate why some agricultural practices did not appear to change.

Although there were positive and significant differences for certain agricultural practices, such as the use of organic fertiliser and crop rotation/mulching, there were also some puzzles arising from the results of this Effectiveness Review. For example, although the project provided both training and inputs to help participants store grain, there were no significant differences in the number of households storing grain between the participant and comparison group. Similarly, project participants appeared to show no change in their use of improved seeds. While we can speculate about why this may be, our data do not allow us to unpack these results. We thus recommend further research to ascertain why these outcomes, which appear to be directly related to the project logic, changed far less than others.

APPENDIX 1: THRESHOLDS FOR CHARACTERISTICS OF RESILIENCE

Dimension	Characteristic	Threshold: a household scores positively if...	Directly connected to project logic?
Livelihood viability	*Land ownership*	Household owns at least 4 manzanas.	No
	Crop diversification	Household cultivated at least 2 crop types in the past 12 months.	Yes
	Crop production	Household sold at least 1 córdoba's worth of crops during the past 12 months *(i.e. the household produced enough to be able to sell the surplus).*	Yes
	Adoption of improved production techniques	Household applies at least 4 of the improved agricultural production techniques listed in the questionnaire, including cultivation from a kitchen garden, a forest-pasture plot, use of organic fertiliser or insecticide, etc.	Yes
	Access to markets	Household members take less than 90 minutes to travel to the nearest town, using the methods of transport they most commonly adopt.	No
	Livelihood diversification	At least some female and some male household member(s) engage(s) in non-agricultural work, such that the household is receiving income from at least 3 livelihood sources.	No
	Ownership of productive assets	Household owns at least 3 large assets (bulls, pigs, horses, fridge, TV, satellite dish, oven, grinder, motorbike or other vehicle) or at least 6 small assets (radio, horse/ox cart, solar panel, bicycle and sprayer).	No
Innovation potential	*Understanding of climate change*	Respondent is aware of the concept of climate change, and mentioned at least 3 types of risk that climate change brings to their household.	Yes
	Adoption of new practices or initiatives	Household has tried at least 2 new practices, initiatives, or changes in behaviour since 2010, apart from those that were taken based on instruction or support from an NGO or project.	No
	Ability to influence others	Respondent reports that they sometimes share knowledge of production techniques with other household members or with others in the community, and that these others have at least sometimes applied what they had told them.	Yes
	Access to credit	Household would be able to borrow 4000 córdobas from at least one source, if it were needed for an investment opportunity.	Yes
Access to contingency resources and support	*Grain storage*	Household has stored grain for future use as food in the past 12 months.	Yes
	Savings	Respondent estimates that the household's savings would allow them to survive for more than 30 days in an emergency.	No
	Access to remittances or state support	Household had some income from remittances or payments from government during the past 12 months.	No
Integrity of the natural	*Location of house*	House is not located on low ground, in a floodplain, or on the side of a hill or	No

Dimension	Characteristic	Threshold: a household scores positively if...	Directly connected to project logic?
and built environment		volcano.	
	Access to safe drinking water	Household's main source of water for drinking is a private well or a municipal water supply.	No
	Access to irrigation	At least some of the land cultivated by the household in the past 12 months is irrigated.	No
	Tree planting	Household has planted at least 10 trees since 2012.	Yes
Social and institutional capability	*Solidarity in the community*	Respondent reports that the household provided support to others in the community and/or received support from others in the community at least 1 time during the past 12 months.	No
	Involvement in risk management and emergency preparedness committee	The respondent is aware of the existence of a risk management and emergency preparedness committee within the community, and some household member has attended a meeting during the past six months.	No
	Risk-management plan	Respondent is aware that the community has a risk-management plan that was updated within the past three years, and has some understanding of the contents of the plan.	No
	Communal actions taken to mitigate risk	Respondent is aware of at least two types of activities that have been carried out in the community to mitigate risk, during the past 12 months.	No
	Early-warning system	The respondent is aware that an early-warning system exists within the community, is reasonably confident that they would receive warning in advance of a natural disaster, and is at least partly aware of what they should do if they were to receive such warning.	No

APPENDIX 2: BASELINE STATISTICS BEFORE MATCHING

	Overall				Direct project participants				Other cooperative members			
	Intervention mean	Comparison mean	Difference	t statistic	Intervention mean	Comparison mean	Difference	t statistic	Intervention mean	Comparison mean	Difference	t statistic
Number of members of household in 2010	4.418	4.652	-0.234	-1.34	4.545	4.652	-0.108	-0.50	4.250	4.652	-0.402*	-1.68
Proportion of household members who were children (under 16 years old) in 2010 %	34.771	38.858	-4.087**	-1.98	36.118	38.858	-2.740	-1.11	32.980	38.858	-5.878**	-2.04
Household had only one adult member in 2010 %	7.910	7.317	0.593	0.24	2.970	7.317	-4.347	-1.57	14.474	7.317	7.157**	2.00
Household had no male adult members in 2010 %	15.254	10.061	5.193*	1.72	7.921	10.061	-2.140	-0.64	25.000	10.061	14.939***	3.55
All adult household members were elderly (over 60 years old) in 2010 %	3.390	3.049	0.341	0.21	1.980	3.049	-1.069	-0.57	5.263	3.049	2.214	0.95
Household head is female %	32.768	20.732	12.037***	3.00	22.772	20.732	2.041	0.44	46.053	20.732	25.321***	4.67
Age of household head in 2010 years	47.977	43.637	4.340***	3.25	47.238	43.637	3.600**	2.21	48.961	43.637	5.323***	2.86
Household head completed primary school %	31.638	27.439	4.199	0.99	27.723	27.439	0.284	0.06	36.842	27.439	9.403	1.63
Household head completed middle school %	10.169	3.049	7.121***	3.37	2.970	3.049	-0.078	-0.04	19.737	3.049	16.688***	5.64
Household head completed high school %	6.780	1.829	4.950***	2.88	0.990	1.829	-0.839	-0.58	14.474	1.829	12.644***	5.09
Age of respondent in 2010 years	42.723	39.366	3.357**	2.48	40.030	39.366	0.664	0.40	46.303	39.366	6.937***	3.74
Respondent completed primary school %	38.418	32.012	6.406	1.45	36.634	32.012	4.621	0.86	40.789	32.012	8.777	1.46
Respondent completed middle school %	11.864	6.098	5.767**	2.27	7.921	6.098	1.823	0.65	17.105	6.098	11.008***	3.19
Respondent completed high school %	5.085	2.134	2.951*	1.81	1.980	2.134	-0.154	-0.09	9.211	2.134	7.076***	3.07
Proportion of adult household members in 2010 who completed primary school %	44.364	38.549	5.814*	1.71	38.772	38.549	0.223	0.05	51.795	38.549	13.246***	2.85
Proportion of adult household members in 2010 who completed middle school %	18.002	10.091	7.911***	3.67	10.677	10.091	0.585	0.26	27.738	10.091	17.647***	5.90
Proportion of adult household members in 2010 who completed high school %	9.181	4.680	4.501***	2.82	3.746	4.680	-0.934	-0.57	16.404	4.680	11.724***	5.17
Land area cultivated by household in 2010 Manzanas	2.191	2.435	-0.244	-1.09	2.762	2.435	0.328	1.18	1.431	2.435	-1.004***	-3.47
Household owned any land in 2010 %	83.051	77.439	5.612	1.49	87.129	77.439	9.690**	2.12	77.632	77.439	0.193	0.04
Land area owned by household in 2010 Manzanas	5.750	9.530	-3.780***	-2.93	6.968	9.530	-2.563	-1.52	4.132	9.530	-5.399***	-2.88
Household had title showing ownership of land in 2010 %	54.237	50.915	3.323	0.71	58.416	50.915	7.501	1.32	48.684	50.915	-2.230	-0.35
Respondent personally owned land in 2010 %	55.932	41.768	14.164***	3.07	55.446	41.768	13.677**	2.43	56.579	41.768	14.811**	2.35
Land area owned by respondent in 2010 %	3.145	3.606	-0.460	-0.61	3.626	3.606	0.021	0.02	2.507	3.606	-1.099	-1.09
Respondent had title showing ownership of land in 2010 %	36.723	29.878	6.845	1.57	37.624	29.878	7.746	1.46	35.526	29.878	5.648	0.96
Household had a kitchen garden in 2010 %	44.633	32.317	12.316***	2.76	56.436	32.317	24.119***	4.46	28.947	32.317	-3.370	-0.57

	Overall				Direct project participants				Other cooperative members			
	Interven-tion mean	Compari-son mean	Difference	t statistic	Interven-tion mean	Compar-ison mean	Difference	t statistic	Interven-tion mean	Compar-ison mean	Difference	t statistic
Household had forest-pasture land in 2010 %	30.508	18.293	12.216***	3.16	41.584	18.293	23.291***	4.93	15.789	18.293	-2.503	-0.51
Number of crops produced in 2010	2.672	2.363	0.310	1.59	3.376	2.363	1.013***	4.23	1.737	2.363	-0.626***	-2.73
Number of crops sold in 2010	1.525	1.079	0.446***	3.21	1.931	1.079	0.851***	4.98	0.987	1.079	-0.092	-0.59
Household gained income from farming in 2010 %	67.797	61.585	6.211	1.39	77.228	61.585	15.642***	2.91	55.263	61.585	-6.322	-1.01
Household gained income from poultry in 2010 %	62.712	58.841	3.870	0.85	71.287	58.841	12.446**	2.26	51.316	58.841	-7.526	-1.19
Household gained income from cattle in 2010 %	34.463	34.146	0.317	0.07	45.545	34.146	11.398**	2.08	19.737	34.146	-14.409**	-2.45
Household gained income from pigs in 2010 %	55.932	48.476	7.457	1.49	54.455	48.476	5.980	1.05	57.895	48.476	9.419	1.35
Household gained income from fishing in 2010 %	5.085	6.728	-1.643	-0.73	4.950	6.728	-1.777	-0.64	5.263	6.728	-1.465	-0.47
Household gained income from a business in 2010 %	16.571	14.067	2.504	0.75	11.111	14.067	-2.956	-0.76	23.684	14.067	9.617**	2.07
Household gained income from casual labour in 2010 %	27.684	35.976	-8.292*	-1.89	31.683	35.976	-4.292	-0.79	22.368	35.976	-13.607**	-2.27
Household gained income from domestic work in 2010 %	7.910	3.354	4.556**	2.26	6.931	3.354	3.577	1.57	9.211	3.354	5.857**	2.24
Household gained income from self-employment in 2010 %	16.949	22.561	-5.612	-1.49	15.842	22.561	-6.719	-1.45	18.421	22.561	-4.140	-0.79
Household gained income from a formal job in 2010 %	14.124	6.707	7.417***	2.75	12.871	6.707	6.164**	1.98	15.789	6.707	9.082**	2.58
Household gained income from remittances in 2010 %	20.339	6.707	13.632***	4.67	20.792	6.707	14.085***	4.20	19.737	6.707	13.030***	3.60
Household gained income from government support in 2010 %	3.390	5.793	-2.403	-1.19	2.970	5.793	-2.822	-1.12	3.947	5.793	-1.845	-0.64
Income contributed by respondent in 2010 %	40.768	32.957	7.811***	2.74	36.693	32.957	3.736	1.10	46.184	32.957	13.227***	3.41
Household was in the lowest 20% of the sample according to wealth indicators recalled from 2010[a] %	8.475	26.220	-17.745***	-4.86	5.941	26.220	-20.279***	-4.43	11.842	26.220	-14.377***	-2.68
Household was in the second 20% of the sample according to wealth indicators recalled from 2010[a] %	10.169	25.305	-15.135***	-4.12	13.861	25.305	-11.443**	-2.41	5.263	25.305	-20.042***	-3.89
Household was in the middle 20% of the sample according to wealth indicators recalled from 2010[a] %	18.079	21.037	-2.957	-0.79	16.832	21.037	-4.205	-0.92	19.737	21.037	-1.300	-0.25
Household was in the fourth 20% of the sample according to wealth indicators recalled from 2010[a] %	31.638	13.720	17.919***	4.91	34.653	13.720	20.934***	4.84	27.632	13.720	13.912***	2.98
Household was in the upper 20% of the sample according to wealth indicators recalled from 2010[a] %	31.638	13.720	17.919***	4.91	28.713	13.720	14.993***	3.53	35.526	13.720	21.807***	4.58

	Overall				Direct project participants				Other cooperative members			
	Interven-tion mean	Compari-son mean	Difference	t statistic	Interven-tion mean	Compar-ison mean	Difference	t statistic	Interven-tion mean	Compar-ison mean	Difference	t statistic
Distance of house from transport connection in 2010 Minutes	31.780	27.893	3.886	1.24	41.446	27.893	13.552***	3.44	18.934	27.893	-8.959**	-2.25
Distance of house from nearest town Minutes	75.362	105.152	-29.791***	-5.09	87.604	105.152	-17.548**	-2.33	59.092	105.152	-46.060***	-5.79
Member of household was in a producers' cooperative in 2010 %	75.141	78.354	-3.212	-0.82	76.238	78.354	-2.116	-0.45	73.684	78.354	-4.669	-0.88
Female member of household was in a producers' cooperative in 2010 %	59.322	61.890	-2.568	-0.56	59.406	61.890	-2.484	-0.45	59.211	61.890	-2.680	-0.43
Household has received support from CIPRES since 2010 %	38.983	19.512	19.471***	4.84	56.436	19.512	36.923***	7.67	15.789	19.512	-3.723	-0.75
Household has received support from Hambre Cero since 2010 %	11.864	11.585	0.279	0.09	12.871	11.585	1.286	0.35	10.526	11.585	-1.059	-0.26
Number of observations	**177**	**328**			**101**	**328**			**76**	**328**		

[a] The construction of the wealth index is described in Section 5.7.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey.

APPENDIX 3: METHODOLOGY USED FOR PROPENSITY-SCORE MATCHING

The analysis of outcome variables presented in Section 5 of this review, involved group mean comparisons using propensity-score matching (PSM). The basic principle of PSM is to match each participant with a non-participant that was observationally similar at baseline and to obtain the intervention effect by averaging the differences in outcomes across the two groups after project completion. Unsurprisingly, there are different approaches to matching, i.e. to determining whether or not a woman is observationally 'similar' to another woman. For an overview, we refer to Caliendo and Kopeinig (2008).[12] This appendix describes and tests the specific matching procedure followed in this Effectiveness Review.

Estimating propensity scores

Given that it is extremely hard to find two individuals with exactly the same characteristics, Rosenbaum and Rubin (1983) demonstrate that it is possible to match individuals using a prior probability for an individual to be in the intervention group, naming it *propensity score*. More specifically, propensity scores are obtained by pooling the units from both the intervention and comparison groups and using a statistical probability model (e.g. a probit regression) to estimate the probability of participating in the project, conditional on a set of observed characteristics.

Tables A3.1 to A3.3 present the probit regression results used to estimate the propensity scores in our context. Table A3.1 shows the probit results for the non-parsimonious models, entering the full set of matching variables considered in this study. To guarantee that none of the matching variables were affected by the intervention, we only considered variables related to baseline, and only those variables that were unlikely to have been influenced by anticipation of project participation (Caliendo and Kopeinig, 2008).

Table A3.1: Estimating the propensity score: non-parsimonious models

	Direct project participants			Other cooperative members		
	Coefficient	Standard error	p-value	Coefficient	Standard error	p-value
Number of members of household in 2010	0.027	0.055	0.617	-0.068	0.079	0.395
Proportion of household members who were children (less than 16 years old) in 2010	-0.735	0.494	0.136	0.639	0.614	0.298
Household had no male adult members in 2010	-0.104	0.358	0.772	0.173	0.365	0.636
All adult household members were elderly (over 60 years old) in 2010	-0.212	0.582	0.716	-0.065	0.521	0.901
Household head is female	0.193	0.253	0.446	0.124	0.270	0.646
Household head completed primary school	0.098	0.315	0.756	-0.562	0.382	0.141
Household head completed middle school	0.011	0.809	0.989	0.734	0.860	0.394
Household head completed high school	-0.176	1.348	0.896	0.545	0.967	0.573

Age of respondent in 2010	-0.007	0.007	0.35	0.032	0.010	0.001
Respondent completed primary school	0.337	0.298	0.259	0.043	0.342	0.9
Respondent completed middle school	0.458	0.544	0.4	0.353	0.706	0.617
Respondent completed high school	-0.099	0.868	0.909	-1.221	0.802	0.128
Proportion of adult household members in 2010 who completed primary school	-0.649	0.550	0.238	0.498	0.622	0.423
Proportion of adult household members in 2010 who completed middle school	-0.439	0.877	0.617	0.428	1.015	0.673
Proportion of adult household members in 2010 who completed high school	-1.119	1.111	0.314	0.522	1.009	0.605
Land area cultivated by household in 2010	0.040	0.042	0.339	-0.167	0.068	0.014
Household owned any land in 2010	0.306	0.270	0.257	0.026	0.313	0.933
Land area owned by household in 2010	-0.029	0.013	0.024	-0.035	0.021	0.108
Respondent personally owned land in 2010	0.073	0.220	0.742	0.307	0.291	0.291
Land area owned by respondent in 2010	0.010	0.015	0.502	-0.016	0.039	0.678
Household has received support from Hambre Cero since 2010	-0.240	0.279	0.39	0.202	0.288	0.484
Number of crops produced in 2010	0.012	0.056	0.832	-0.089	0.090	0.323
Number of crops sold in 2010	0.074	0.070	0.288	0.088	0.106	0.409
Household gained income from farming in 2010	0.046	0.208	0.823	0.201	0.261	0.441
Household gained income from poultry in 2010	0.361	0.185	0.052	-0.308	0.209	0.141
Household gained income from cattle in 2010	0.288	0.175	0.1	-0.556	0.240	0.02
Household gained income from pigs in 2010	-0.283	0.179	0.113	0.359	0.196	0.067
Household gained income from fishing in 2010	-0.322	0.338	0.341	0.042	0.396	0.915
Household gained income from a business in 2010	-0.517	0.253	0.041	a		
Household gained income from casual labour in 2010	-0.065	0.178	0.717	0.00294	0.218317	0.989
Household gained income from domestic work in 2010	0.160	0.395	0.685	0.878519	0.407688	0.031
Household gained income from self-employment in 2010	-0.400	0.214	0.062	-0.08568	0.244949	0.726
Household gained income from a formal job	0.454	0.279	0.103	0.216849	0.31411	0.49

in 2010						
Household gained income from remittances in 2010	0.615	0.253	0.015	0.433377	0.294354	0.141
Income contributed by respondent in 2010	0.000	0.003	0.897	0.002122	0.003184	0.505
Wealth index (2010)	0.211	0.048	0	0.230273	0.052684	0
Member of household was in a producers' cooperative in 2010	-0.172	0.281	0.541	-0.19197	0.323446	0.553
Female member of household was in a producers' cooperative in 2010	-0.074	0.237	0.755	-0.33833	0.288482	0.241

[a] Variable dropped because of estimability or collinearity with other variables.

Notes: Probit regression. Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey. Explanatory variables expressed as $x = 1$ represent binary variables taking values of either 0 or 1. The dependent variable is 1 if the household is in one of the project villages, and 0 otherwise. The coefficients represent the contribution of each explanatory variable/characteristic to the probability that a household participates in the project.

The final set of variables used in the matching process were identified using a backwards stepwise regression for each of the two groups, to identify those variables correlated with being in an intervention group at *p*-values of 0.20 or less. For the households of direct project participants, 16 such variables were identified, and for households of other cooperative members, 14 such variables were identified. Tables A3.2 and A3.3 show the results of the probit models restricted to these final (restricted) sets of matching variables.

Table A3.2: Estimating the propensity score: parsimonious model for households of direct project participants

	Coefficient	Standard error	p-value
Household gained income from poultry in 2010	0.369	0.175	0.035
Proportion of household members who were children (under 16 years old) in 2010	-0.495	0.367	0.178
Household gained income from a business in 2010	-0.518	0.239	0.03
Number of crops sold in 2010	0.092	0.052	0.079
Household gained income from a formal job in 2010	0.406	0.267	0.128
Member of household was in a producers' cooperative in 2010	-0.245	0.191	0.199
Wealth index 2010	0.220	0.043	0
Land area owned by household in 2010	-0.017	0.007	0.016
Respondent completed primary school	0.468	0.244	0.055
Household gained income from remittances in 2010	0.593	0.235	0.012
Household gained income from self-employment in 2010	-0.426	0.206	0.038
Proportion of adult household members in 2010 who completed primary school	-0.593	0.330	0.072
Household gained income from cattle in 2010	0.238	0.167	0.155
Proportion of adult household members in 2010 who completed high school	-1.180	0.676	0.081
Household gained income from pigs in 2010	-0.280	0.171	0.101
Household owned any land in 2010	0.351	0.233	0.133

Notes: Probit regression. Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey. Explanatory variables expressed as $x = 1$ represent binary variables taking values of either 0 or 1. The dependent variable is 1 if the household is in one of the project villages, and 0 otherwise. The coefficients represent the contribution of each explanatory variable/characteristic to the probability that a household participates in the project.

Table A3.3: Estimating the propensity score: parsimonious model for households of other cooperative members

	Coefficient	Standard error	p-value
Land area owned by household in 2010	-0.035	0.016	0.028
Land area cultivated by household in 2010	-0.171	0.055	0.002
Female member of household was in a producers' cooperative in 2010	-0.431	0.189	0.022
Respondent personally owned land in 2010	0.313	0.191	0.100
Household gained income from cattle in 2010	-0.571	0.222	0.010
Household head completed primary school	-0.478	0.312	0.125
Household head completed middle school	1.372	0.358	0.000
Household gained income from poultry in 2010	-0.250	0.187	0.181
Age of respondent in 2010	0.028	0.007	0.000
Household gained income from remittances in 2010	0.524	0.269	0.051
Household gained income from domestic work in 2010	1.011	0.361	0.005
Wealth Index 2010	0.224	0.046	0.000
Proportion of adult household members in 2010 who completed primary school	0.532	0.389	0.171
Household gained income from pigs in 2010	0.312	0.184	0.089

Notes: Probit regression. Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey. Explanatory variables expressed as $x = 1$ represent binary

variables taking values of either 0 or 1. The dependent variable is 1 if the household is in one of the project villages, and 0 otherwise. The coefficients represent the contribution of each explanatory variable/characteristic to the probability that a household participates in the project.

Defining the region of common support

After estimating the propensity scores, the presence of a good *common support area* needs to be checked. The area of common support is the region where the propensity-score distributions of the intervention and comparison groups overlap. The common support assumption ensures that 'treatment observations have a comparison observation "nearby" in the propensity score distribution' (Heckman, LaLonde and Smith, 1999). Since some significant differences were found between the intervention and comparison groups in terms of their baseline characteristics (as detailed in Section 4.2), some of the women in the intervention group are too different from the comparison group to allow for meaningful comparison. We used a minima and maxima comparison, deleting all observations whose propensity score was smaller than the minimum and larger than the maximum in the opposite group (Caliendo and Kopeinig, 2008). For the direct project participants, 10 of the 101 households interviewed in the project communities and 9 of the 328 households in the comparison communities were dropped because they lay outside the area of common support. For the other cooperative members, 9 of the 76 households interviewed in the project communities and 138 of the 328 households in the comparison communities were dropped for that reason. The consequence of dropping project participant households is that the estimates of differences in outcome characteristics between the various intervention groups only apply to those intervention households that were not dropped; that is, they do not represent the surveyed population as a whole.

Matching intervention and comparison households

Following Rosenbaum and Rubin (1983), after estimating the propensity scores and defining the area of common support, individuals are matched on the basis of their propensity score. The literature has developed a variety of matching procedures. For the main results presented in this Effectiveness Review we chose to employ the method of kernel matching (note that we use alternative matching procedures as a means of robustness checks in Appendix 4). Kernel matching weights the contribution of each comparison group member, attaching greater weight to those comparison observations that provide a better match with the intervention observations. One common approach is to use the normal distribution with mean zero as a kernel, and weights given by the distribution of the differences in propensity score. Thus 'good' matches are given greater weight than 'poor' matches.

When using PSM, standard errors of the estimates were bootstrapped using 1000 repetitions (clustered by village), to account for the additional variation caused by the estimation of the propensity scores and the determination of the common support.[13]

Check balancing

For PSM to be valid, the intervention group and the matched comparison group need to be balanced, in that they need to be similar in terms of their observed baseline characteristics. This should be checked. The most straightforward method of doing this is to test whether there are any statistically significant differences in baseline covariates between the intervention and comparison group in the matched sample. Efforts were made to ensure that the covariates were balanced across groups at *p*-values greater than 0.20. The balance of each of the matching variables after kernel matching is shown in Tables A3.4 and A3.5. None of the variables implemented for the matching are statistically significant in the matched sample.

Table A3.4: Balancing test on the restricted set of matching variables for households of direct project participants

	Treated	Untreated	p-value
Household gained income from a business in 2010	0.118	0.129	0.817
Proportion of household members who were children (under 16 years old) in 2010	0.362	0.402	0.191
Household gained income from cattle in 2010	0.459	0.400	0.441
Number of crops sold in 2010	1.647	1.406	0.21
Household gained income from poultry in 2010	0.682	0.682	1
Household gained income from a formal job in 2010	0.118	0.094	0.621
Household gained income from remittances in 2010	0.153	0.106	0.364
Member of household was in a producers' cooperative in 2010	0.800	0.776	0.709
Respondent completed primary school	0.353	0.306	0.517
Wealth index 2010	0.571	0.706	0.666
Household gained income from self-employment in 2010	0.153	0.176	0.681
Proportion of adult household members in 2010 who completed primary school	0.382	0.360	0.674
Household gained income from pigs in 2010	0.506	0.565	0.445
Proportion of adult household members in 2010 who completed high school	0.035	0.051	0.429
Household owned any land in 2010	0.882	0.871	0.817
Land area owned by household in 2010	6.765	6.870	0.937

Notes: Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey. Explanatory variables expressed as $x = 1$ represent binary variables taking values of either 0 or 1.

Table A3.5: Balancing test on the restricted set of matching variables for households of other cooperative members

	Treated	Untreated	p-value
Land area owned by household in 2010	3.595	2.948	0.416
Land area cultivated by household in 2010	1.470	1.364	0.746
Female member of household was in a producers' cooperative in 2010	0.591	0.601	0.904
Respondent personally owned land in 2010	0.530	0.505	0.776
Household gained income from cattle in 2010	0.167	0.262	0.187
Household head completed primary school	0.318	0.338	0.814
Household head completed middle school	0.121	0.094	0.614
Household gained income from poultry in 2010	0.500	0.518	0.835
Age of respondent in 2010	46.076	45.737	0.892
Household gained income from remittances in 2010	0.182	0.187	0.943
Household gained income from domestic work in 2010	0.076	0.122	0.38
Wealth Index 2010	0.826	0.838	0.975
Proportion of adult household members in 2010 who completed primary school	0.483	0.496	0.839
Household gained income from pigs in 2010	0.515	0.565	0.567

Notes: Variables dated 2010 are estimates, based on recall data or reconstructed from the composition of the household at the time of the survey. Explanatory variables expressed as $x = 1$ represent binary variables taking values of either 0 or 1.

APPENDIX 4: ROBUSTNESS CHECKS

In order to address the validity of the results presented in Section 5, a series of robustness checks are carried out to check if the preferred matching algorithm is the one that best performs the matching between intervention and comparison groups. This section presents a number of alternative matching algorithms used to test the robustness of the estimates presented in Section 5.

1 Multivariate regression

The first basic specification for estimating the impact of project participation is an Ordinary Least Squares (OLS) model when the dependent variable is continuous or a probit model when the dependent variable is binary.

$$Y_i = \alpha + \beta_1 Project\ participation_i + \delta' X_i + \varepsilon_i$$

Where Y_i is the dependent variable; X_i is a vector of household covariates used in the model in table A2.1; finally the variable of interest is the dummy variable *Project Participation* that assumes value equal to one when the household is enrolled in the project, zero otherwise. When the dependent variable Y_i is a binary variable, a probit model replaces the OLS specification. It is important to note that in the absence of randomized allocation of the project among the population in our sample, OLS and probit models fail to identify the causal effect of the programme, and can only be used as additional qualitative checks for the non-parametric estimates. Only the estimate of β_1 will be reported.

2 Propensity Score Matching – Nearest Neighbour

The Nearest Neighbour (NN) matching algorithm finds an observation from the comparison group to be matched with an observation from a treated individual that is closest in terms of their propensity score. Several variants of NN matching are possible, e.g. NN matching 'with replacement' and 'without replacement'. In the former case, an untreated individual can be used more than once as a match, whereas in the latter case it is considered only once. Matching with replacement involves a trade-off between bias and variance. If we allow replacement, the average quality of matching will increase and the bias will decrease. This is of particular interest with data where the propensity score distribution is very different in the treatment and the control group (Caliendo and Kopeinig, 2008).

3 Propensity Score Matching – Caliper

NN matching faces the risk of bad matches, if the closest neighbour is far away. This can be avoided by imposing a tolerance level on the maximum propensity score distance (caliper). Imposing a caliper works in the same direction as allowing for replacement. Bad matches are avoided and hence the matching quality rises. However, if fewer matches can be performed, the variance of the estimates increases. Applying caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper ('propensity range') and is closest in terms of propensity score. Estimates in this analysis will impose a calliper of 0.05.

4 Propensity Score Weighting

Following the example of Hirano and Imbens (2001)[14] we implement a regression adjustment with weights based on the propensity score. The average treatment effect can be estimated in a parametric framework as follows:

$$Y_i = \alpha + \beta_1 Project\ participation_i + \delta_2' Z_i + \delta_1' X_i + \varepsilon_i$$

Where Y_i represents the outcome of interest; $Project\ participation_i$ is a dummy binary variable equal to one if an individual/household is enrolled into the programme and zero otherwise; X_i is a vector of matching covariates used to estimate the propensity score match; and Z_i is a vector of control variables which cannot be used for the matching as they are not supposed to influence project participation. The regression is estimated with weights equal to one for the treated units and $\hat{e}(x)/(1 - \hat{e}(x))$ for control units.

This parametric regression analysis framework has the advantage of allowing us to explore heterogeneity in the treatment effect. Moreover it allows us to control for variables that cannot be included in the propensity score equation. The robustness check tables will only report β_1.

We focus this exercise on the main results, looking primarily at the resilience indicators.

Table A3.1: Resilience Index

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Base Resilience Index	0.084***	0.088***	0.088***	0.079***
	(0.015)	(0.024)	(0.024)	(0.016)
N	481	482	481	482
Alkire-Foster Index	0.105***	0.104***	0.104***	0.096***
	(0.021)	(0.033)	(0.034)	(0.021)
N	481	482	481	482

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* p<0.1, ** p<0.05, *** p<0.01

Table A3.2: Livelihood Viability

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Land ownership	0.007	0.138*	0.138*	0.001
	(0.008)	(0.072)	(0.072)	(0.001)
N	481	482	482	481
Crop diversification	0.152**	0.125*	0.125*	0.167***
	(0.059)	(0.075)	(0.074)	(0.063)
N	481	482	482	481
Crop production	-0.034	-0.013	-0.013	-0.031
	(0.060)	(0.077)	(0.075)	(0.065)
N	481	482	482	481
Use of improved agricultural techniques	0.162***	0.144**	0.144**	0.185***
	(0.059)	(0.071)	(0.072)	(0.062)
N	481	482	482	481
Access to markets	-0.051	0.100	0.100	-0.021
	(0.061)	(0.069)	(0.072)	(0.023)
N	481	482	482	481
Livelihood diversification	0.039	0.006	0.006	0.016
	(0.055)	(0.067)	(0.067)	(0.048)
N	481	482	482	481
Productive assets	0.043	-0.031	-0.031	0.033
	(0.043)	(0.059)	(0.062)	(0.030)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table A3.3: Innovation Potential

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Understanding of climate change	0.200***	0.244***	0.244***	0.210***
	(0.050)	(0.062)	(0.063)	(0.059)
N	481	482	482	481
Adoption of new practices	0.151***	0.144**	0.144**	0.131**
	(0.050)	(0.070)	(0.069)	(0.057)
N	481	482	482	481
Ability to influence others	0.114**	0.031	0.031	0.137***
	(0.051)	(0.070)	(0.067)	(0.051)
N	481	482	482	481
Access to credit	-0.029	-0.069	-0.069	-0.029
	(0.027)	(0.043)	(0.042)	(0.022)
N	449	482	482	449

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Table A3.4: Access to Contingency Resources and Support

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Grain storage	-0.036	0.044	0.044	-0.037
	(0.053)	(0.072)	(0.074)	(0.056)
N	481	482	482	481
Savings	-0.044	-0.044	-0.044	-0.049
	(0.050)	(0.067)	(0.065)	(0.052)
N	481	482	482	481
Access to remittances/support	-0.100**	-0.069	-0.069	-0.148**
	(0.050)	(0.069)	(0.066)	(0.060)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* p<0.1, ** p<0.05, *** p<0.01

Table A3.5: Integrity of the Natural and Built Environment

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Location of house	-0.009	-0.044	-0.044	-0.015
	(0.056)	(0.073)	(0.071)	(0.058)
N	481	482	482	481
Access to safe drinking water	0.097**	0.106*	0.106*	0.058***
	(0.042)	(0.058)	(0.057)	(0.022)
N	468	482	482	468
Access to irrigation	0.004	-0.038	-0.038	0.001
	(0.005)	(0.048)	(0.048)	(0.003)
N	465	482	482	465
Tree planting	0.323***	0.338***	0.338***	0.351***
	(0.058)	(0.071)	(0.071)	(0.063)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* p<0.1, ** p<0.05, *** p<0.01

Table A3.6: Social and Institutional Capability

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Solidarity in the community	0.201***	0.106	0.106	0.167***
	(0.057)	(0.070)	(0.073)	(0.061)
N	481	482	482	481
Involvement in risk management committee	0.246***	0.237***	0.237***	0.240***
	(0.047)	(0.064)	(0.064)	(0.054)
N	481	482	482	481
Knowledge of risk management plan	0.246***	0.237***	0.237***	0.240***
	(0.047)	(0.064)	(0.064)	(0.054)
N	481	482	482	481
Communal actions taken to mitigate risk	0.201***	0.194***	0.194***	0.221***
	(0.056)	(0.073)	(0.071)	(0.060)
N	481	482	482	481
Early warning system	0.129***	0.162***	0.162***	0.135***
	(0.037)	(0.059)	(0.061)	(0.042)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A3.7: Indexes for Each Resilience Dimension

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Index of livelihood viability	0.059***	0.067*	0.067*	0.059***
	(0.023)	(0.036)	(0.037)	(0.022)
N	481	482	482	481
Index of innovation potential	0.100***	0.087**	0.087**	0.094***
	(0.026)	(0.037)	(0.037)	(0.028)
N	481	482	482	481
Index of access to contingency resources and support access	-0.048*	-0.023	-0.023	-0.053*
	(0.028)	(0.039)	(0.040)	(0.029)
N	481	482	482	481
Index of integrity of natural and built environment	0.086***	0.091***	0.091***	0.085***
	(0.023)	(0.028)	(0.028)	(0.023)
N	481	482	482	481
Index of social and institutional capability	0.185***	0.181***	0.181***	0.170***
	(0.032)	(0.044)	(0.044)	(0.033)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A3.8: Agricultural Activities

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Household has a kitchen garden	0.080**	0.106**	0.106**	0.087*
	(0.037)	(0.053)	(0.053)	(0.046)
N	452	482	482	452
Household has forest-pasture land	0.162***	0.112**	0.112*	0.168***
	(0.036)	(0.055)	(0.059)	(0.036)
N	481	482	482	481
Household using organic fertilizer since 2010	0.115***	0.175***	0.175***	0.130***
	(0.037)	(0.056)	(0.054)	(0.041)
N	481	482	482	481
Households using organic pesticide since 2010	0.126***	0.175***	0.175***	0.140***
	(0.032)	(0.053)	(0.052)	(0.035)
N	481	482	482	481
Household practicing crop rotation since 2010	0.164***	0.150**	0.150**	0.216***
	(0.049)	(0.065)	(0.062)	(0.050)
N	481	482	482	481
Household practicing mulching since 2010	0.157***	0.087	0.087	0.155**
	(0.059)	(0.075)	(0.070)	(0.063)
N	481	482	482	481
Number of crop types produced in the past 12 months	0.477**	0.625**	0.625**	0.579***
	(0.213)	(0.288)	(0.285)	(0.213)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* p<0.1, ** p<0.05, *** p<0.01

Table A3.9: Dietary Diversity

	(1) OLS / probit	(2) PSM NN	(3) PSM Caliper	(4) Propensity Score Weighting
Number of different food types consumed by the respondent in the past 7 days	0.501***	0.494**	0.494**	0.387**
	(0.176)	(0.237)	(0.226)	(0.169)
N	481	482	482	481
Number of different food types consumed by men in the household in the past 7 days	0.547***	0.638***	0.638**	0.394**
	(0.183)	(0.247)	(0.252)	(0.174)
N	437	438	438	437
Female respondents with positive food diversity	0.172***	0.225***	0.225***	0.190***
	(0.041)	(0.063)	(0.060)	(0.047)
N	481	482	482	481
Other male household members with positive food diversity	0.160***	0.213***	0.213***	0.164***
	(0.044)	(0.071)	(0.068)	(0.049)
N	437	438	438	437
Female respondents eating vegetables at least three times a week	0.169***	0.125*	0.125*	0.184***
	(0.056)	(0.072)	(0.074)	(0.059)
N	481	482	482	481
Female respondents eating fruits at least three times a week	0.192***	0.231***	0.231***	0.208***
	(0.054)	(0.079)	(0.075)	(0.061)
N	481	482	482	481

Robust standard errors in parentheses. PSM estimates bootstrapped 1000 repetitions. Probit specifications show marginal effects at the mean.

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

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NOTES

1 Information is available here:
http://www.economiafamiliar.gob.ni/index.php?option=com_content&view=article&id=672&Itemid=228

2 1 manzana = 1 hectare/approx 2.5 acres

3 The threshold of 10 per cent is chosen as this is widely used in the impact evaluation and economics literature at large.

4 1 manzana = 1 hectare/approx 2.5 acres

5 1 quintale = approx 100lbs/46 kg

6 Logarithmic transformation reduces the effect of extreme values/outliers in the data, and therefore increases confidence in the analysis.

7 This approach was adapted from the Household Dietary Diversity Score approach, described in Anne Swindale and Paula Bilinsky, *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide, version 2, Food and Nutrition Technical Assistance Project (FANTA)*, September 2006: http://www.fantaproject.org/monitoring-and-evaluation/household-dietary-diversity-score. The difference with the HDDS approach was that recall was requested over a seven-day period, rather than over the past 24 hours.

8 The results in Columns 2, 4 and 6 exclude households where no male adult was present

9 Cronbach's alpha was used to measure this inter-item correlation. The Cronbach's alpha obtained for all the indicators for the recalled 2010 data was 0.747. This alpha was increased to 0.772 by removing those items that had a low correlation with the others. The alpha derived for the index of change in wealth indicators was originally 0.744, and was increased to 0.762 by removing those items that had a low correlation with the others.

10 This approach is described in 'A Multidimensional Approach to Measuring Resilience', Oxfam GB working paper, August 2013: http://policy-practice.oxfam.org.uk/publications/a-multidimensional-approach-to-measuring-resilience-302641.

11 It will be noted that in calculating these overall measures of resilience, each of the individual characteristics presented in Table 5.10 was weighted equally. This means that the index is weighted more towards characteristics of livelihood viability, and less so towards the other four dimensions. Alternative weights could be given to the various characteristics and dimensions, which would necessarily result in changes in the overall indices and potentially in the magnitude of differences between the intervention and comparison groups.

12 Caliendo, M. and Kopeinig, S. 2008. Some Practical Guidance for the Implementation of Propensity Score Matching, *Journal of Economic Surveys*, Wiley Blackwell, vol. 22(1), pages 31–72.

13 Bootstrapping is a statistical procedure where repeated samples are drawn from the original sample with replacement. This results in a statistical distribution of parameter estimates (the sampling distribution). The bootstrapped standard error is the standard deviation of this sampling distribution and it can be shown that as the number of repeated samples becomes large, provided certain technical conditions are met, this is a good method to determine the standard error of the estimate.

14 Hirano, K. & Imbens G.W. (2001), "Estimation of Causal Effects using Propensity Score Weighting: An Application to Data on Right Heart Catheterization" Health Services & Outcomes Research Methodology, vol. 2, pp. 259–278.

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