IMPACT ASSESSMENT REPORT

Mexico

Community-based Forestry Development Project in Southern States (DECOFOS)

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IFAD
Investing in rural people

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Executive summary

The territory of Mexico is covered by forests and wildland up to about 73% of the total territory (World Bank, 2015 and CONAFOR, 2012). This corresponds to around 140 million hectares, 80% of which are owned by communities and *ejidos*. Starting from the '80s, Mexico has experienced one of the largest deforestation rates in Latin America due to a number of complex socio-economic and political reasons which have reduced incentives to the sustainable use of forests with negative consequences for their long term conservation (Segura, 2000).

To address and overcome problems linked to deforestation and forest degradation, the Community-based Forestry Development Project in Southern States (Desarrollo Comunitario Forestal en los Estados del Sur – DECOFOS) was designed and implemented from March 2011 to September 2016 with contribution from the Government of Mexico, IFAD, the Global Environment Facility (GEF) and project beneficiaries. The project had two main components. The first component was mainly meant to raise awareness of climate change and of sustainable use and management of natural resources through trainings and capacity development. This component could be instrumental to achieving impacts when combined with the second component which had a more tangible connotation. The second component, indeed, consisted on promoting sustainable management and exploitation of forest and natural resources through reforestation, adoption of agroforestry and of good environmental practices, supporting and facilitating business enterprises through the provision of technical and financial support to the start-up of micro-entrepreneurial projects and small-businesses enterprises.

The project was implemented in the three Southern states of Oaxaca, Chiapas and Campeche which have very different characteristics and where implementation posed diverse emphasis on different components according to the development needs of each state and to the agro-ecological and socio-economic characteristic of each state. More in particular, the project focussed more on reforestation and agro-forestry interventions in Campeche, whose topography is rather flat and mainly characterised by large forested areas and very little diversification of income sources, whereas in Chiapas which is a more diversified state in terms of agro-ecology and whose economy offers a number of off-farm and other income opportunities, the project focussed more on providing financial support to start or strengthen micro-enterprises. In Oaxaca[1], on the other hand, the project has a lower number of beneficiaries and was scattered across the various types of interventions including spending more on the first component solely.

This impact assessment investigates whether the DECOFOS project, with its unique mechanisms, contributes to the production of environmental benefits as well as to the increase of well-being of beneficiaries measured through key outcome indicators of poverty reduction, increased nutrition and resilience and increased access to market.

In order to answer these questions, this ex-post evaluation makes use of a quasi-experimental approach that combines quantitative methods and qualitative analysis that was used to enrich project design and to identify a valid counterfactual.

Data are comprised of more than 2,200 household surveys from direct beneficiaries of the project, indirect beneficiaries (those inhabitants of treated villages that did not directly participate to the project) and households that represent the control group. The dataset contains information about

[1] It is also important to note that while the data were being collected, the state of Chiapas and particularly of Oaxaca were hit by a strong earthquake.

households' socioeconomic characteristics, livelihood and income-generating activities, food consumption, social capital, and experience of climatic and socioeconomic shocks.

Results are reported on the general sample and disaggregated by states given the above mentioned differences across them. Positive impacts on a range of economic mobility indicators are reported, particularly with relation to assets and productive asset ownership (across the entire sample) and on reduction of poverty, as well as on income coming from use of natural resources in common area and from business enterprises which was the focus of the project. Results are more varied and less significant for the state of Oaxaca possibly given its more scattered type of intervention.

Beneficiaries are also more resilient across the sample whereas the natural vegetation index measured controlling for precipitation, temperature and coefficient of variation of same climatic indicators, is positive and significant across the entire sample with particular emphasis in Campeche and Oaxaca where, indeed, the project focussed on agroforestry and sustainable use of forest resources as opposed to Chiapas where the focus was on micro-business enterprise.

In terms of social capital there is a stronger participation of women in associations and organizations reflecting the gender component of the project, although this did not translate into higher participation of women in economic activities and business enterprises. Last but not least, access to market is also improved thank to a new transport system since baseline for Campeche and Chiapas.

Overall, the results suggest that there has been a good environmental impacts as reflected by the use of common resources and common land as well as by permits required to access common land and an increase in the use of parcels for agroforestry purposes. The impact is also relevant with regard to the starting of business enterprises as indicated by new business created as well as by a positive impact on total and on productive assets. Results are differentiated across the states and they tend to be robust and strong in those cases where the interventions have been more focussed and designed based on local needs and characteristics of natural and capital endowments (Chiapas and Campeche). In the case of Oaxaca where the intervention has been lower (in terms of financial amount of the intervention and number of beneficiaries) and more scattered, results are less strong and in some case negative. This suggest that a well-structured type of intervention which follow a strong logic with interlinked components is more effective in transforming rural economies and achieving impacts as compared to very largely diversified types of interventions.

1. Introduction

The territory of Mexico is one of the most diverse in terms of biodiversity and different landscapes in the world. Forest area covers about 30% of the territory (World Bank, 2015). When all types of wildlands are included, it accounts for about 73% of the entire territory (CONAFOR, 2012). Forests serve important ecological and environmental functions: Mexican forest ecosystems bear 10% of the world's biological diversity and play a stabilizing function in soil and water regimes as well as an important role in the global carbon balance. From an economic perspective, sustainable forest management can provide a reliable source of income and subsistence products to indigenous and non-indigenous communities through the supply of direct economic goods such as timber and other wooden forest products and a whole set of non-timber forest products (Cavatassi, 2004).

Starting from the '80s, Mexico has experienced one of the largest deforestation rates in Latin America due to a number of complex socio-economic and political reasons which have reduced incentives to the sustainable use of forests with negative consequences for their long term conservation (Segura, 2000). Most of the total forest land in Mexico (about 80%) is owned by communities and *ejidos*[2], however forestry activities represent the main source of income only for a very small proportion of these communities (about 5%). This might be due, among others, to limited technical, productive, managerial and marketing capacities combined with little resources and low organizational skills. According to Segura (2000), the efficiency of the forest community enterprise is a function of the degree of the internal organization of the community, and is related to the importance the community assigns to the forest resource.

As a response to the country forest deforestation and degradation, in March 2011, implementation began of the DECOFOS project, an initiative financed jointly between IFAD, the Global Environment Facility (GEF) and the Government of Mexico. The project had the dual goal of improving the livelihood of people living in poverty and extreme poverty in degraded or marginalized areas and of contributing to climate change adaptation and mitigation through the restoration and revitalization of degraded lands and deforested areas as well as by supporting, both technically and financially, the implementation of sustainable productive activities. This dual goal is in line with policies and programs for poverty reduction that have been promoted in the country during the last 30 years and, most recently, with the "*Cruzada Nacional Contra el Hambre*" which is the main social policy strategy of the Government to eradicate hunger in Mexico. Moreover, project's objectives are also aligned with national policies and programs aimed at promoting the reduction of the negative effects of climate change through increased mitigation and adaptation. The project lasted five years in total and was completed in September, 2016.

The DECOFOS had two main components. The first component consisted in developing the organizational, planning and managerial capacities of beneficiaries in targeted communities and *ejidos* as well as on increasing their awareness of climate change risks and of related adaptation and mitigation options. The second component had a more practical connotation as it consisted in providing technical and financial support to the start-up of micro-entrepreneurial projects and small-

[2] The Mexican Constitution of 1917 introduced the concept of núcleos agrarios putting much more emphasis on social rather than individual interests in managing agricultural land. The 1992 reform and the corresponding Agricultural Law recognized three forms of property for land and water: public, private and social. This last one corresponds to the núcleos agrarios namely, ejidos and rural communities. In particular, the ejido is a traditional land tenure system combining communal ownership with individual use. An ejido can consist of cultivated land, pastureland, or other uncultivated lands on which community members individually use designated parcels and collectively maintain the communal holdings. Both ejidos and rural communities are registered with the Mexican National Agrarian Registry (Registro Agrario Nacional).

businesses enterprises focussed on sustainable production of timber and non-timber forest products, in addition to eco-tourism and other business activities as well as in supporting the adoption of agroforestry and of other good environmental practices aimed at restoring and revitalizing degraded areas.

This impact assessment investigates whether the DECOFOS project, with its unique mechanisms, contributes to well-being of beneficiaries in key outcome indicators of poverty reduction, resilience and environmental benefits to respond to IFAD's strategic objectives and goals.

In order to answer these questions, this ex-post evaluation makes use of a quasi-experimental approach that combines statistical methods and qualitative analysis to identify a valid counterfactual.

As sufficient data was not collected at baseline of the project, we rely on one round of data collected between August and December 2017. Data are comprised of more than 2,200 household surveys from beneficiaries of the project, indirect beneficiaries (those inhabitants of treated villages that did not directly participate to the project) and households that represent the control group. The dataset contains information about households' socioeconomic characteristics, livelihood and income-generating activities, food consumption, social capital, and experience of climatic and socioeconomic shocks.

The remainder of the report is structured as follows. We begin Section 2 by outlining the project's theory of change and elaborating on its key objectives and activities. A description of the target population follows with the main research questions of the assessment. Section 3 provides details on the methodology employed for the assessment, including the construction of the counterfactual, and on the data collected with main summary statistics, whereas section 4 describes the profile of the project area, as well as interventions classified based on expected impact. Section 5 presents the results of the assessment for the full sample and for the sub-samples determined by the type of project intervention, followed by a discussion of the implications of the results and a summary of the main lessons learned in Section 6.

2. Theory of change and main research questions

2.1 DECOFOS theory of change

The linkage between livelihoods, forests and conservation has been largely studied in recent economic literature. The evidence of a converging geography of poverty and natural forests (Angelsen, 2104; World Bank, 2003) has produced a plethora of studies which tried to identify the causes and effects of this two-way link. However, if the downside of this relationship that is, the link between poverty and deforestation/forest degradation, has been widely investigated – with arguments against and in favour of both causal directions– less attention has been paid to the actual and potential role of forests in cushioning and reducing poverty (Angelsen, 2014; Angelsen and Wunder, 2003). It was not until around 1990/2000 that the seminal studies by Campbell et al. (2002) and Cavendish (2000) introduced the concept of environmental income documenting the important contribution of the so called "hidden harvest"[3] (Scoones et al., 1992; Campbell and Luckert, 2002) to total household's income in many developing contexts. This finding was simultaneous to the mounting evidence in the economic literature and policy thinking showing that rural households were increasingly becoming economic agents rather than just plain farmers. In many smallholder settings, off-farm income was gaining a lot of importance and even sometimes outweighing farm income. In such sense, income diversification was a commonly pursued livelihood strategy to increase both the level and stability of household income (Holden, et al., 2004; de Janvry and Sadoulet, 2001; Ellis, 2000; Reardon et al., 2000). Angelsen et al. (2014) provide a thorough survey of the growing forest and environmental income literature from which it emerges that environmental and, in particular, forest income can positively contribute to rural livelihoods in three main ways: (*i*) by supporting current consumption and avoiding falling into deeper poverty, (*ii*) by providing safety nets in response to negative shocks in the various household domains (*e.g.*, agriculture production, health of family members) and filling gaps during seasonal shortfalls (Angelsen et al., 2014; Wunder et al., 2014; McSweeney, 2004; Pattanayak and Sills, 2001; Angelsen and Wunder, 2003; de Beer and McDermott, 1996 among others), (*iii*) finally, by helping the household in moving out of poverty through enabling accumulation of assets (Angelsen et al., 2014; Angelsen and Wunder, 2003). Furthermore, in addition to economic benefits, a mix of reforestation and of adoption of natural resource management practices may contribute to mitigate the negative effects of climatic events with natural regeneration of native forest species (Engel and Parrotta, 2001), enhancing levels of adaptive capacity and resilience of the underlying ecological systems and natural resources (Tompkins and Adger, 2004).

Mexico's territory is covered by forests and wildland up to about 73% of the total territory (World Bank, 2015; CONAFOR, 2012). This corresponds to about 140 million hectares, 80% of which are owned by communities and *ejidos*. The DECOFOS project was designed based on the analysis of the problems affecting the forestry sector in the country and, particularly, in the states of Oaxaca, Chiapas and Campeche, which are mainly driven by deforestation and lack of resources, investments and technical capacity. More in details these problems can be summarized in what follows:

- Deforestation, overexploitation of forest land and ecosystems degradation;

[3] The "hidden harvest" refers to the diversity of goods provided freely from the environment that is, from noncultivated ecosystems such as natural forests, woodlands, wetlands, lakes, rivers, and grasslands.

- Limited technical, productive, managerial and marketing capacities combined with little resources and low organizational skills;
- Lack of investment and market opportunities;
- Lack of institutional support for community initiatives.

The list of issues highlighted above have clearly led to a vicious circle driven by deforestation and degradation of natural resources which has, in turn, caused progressive marginalization of forest communities' population (especially young people) and which has led to increased migration towards big urban centres and the US. In such context, forestry and related activities and resources have constituted mainly a subsistence strategy for marginalized forest communities' members. By restoring and re-foresting degraded areas together with the provision of technical and financial support to the development of micro-enterprises and sustainable production initiatives, the project tried to pursue a boost in the productive sector of these areas and enlarge the set of income generating opportunities for groups of small-scale producers while, at the same time, containing ecosystems degradation and reducing the negative effects of climate change.

To achieve these objectives, the project was structured around two main components:

- **Component 1: Improve organizational, planning, and managerial capacities of local communities/*ejidos* including climate change mitigation and adaptation**. This component was implemented through the delivery of 294 training courses and workshops mainly related to (*i*) climate change effects and the adoption of good agricultural/environmental practices to adapt and mitigate these effects; (*ii*) the formulation of local development plans, participative environmental assessments, and business plans.
- **Component 2: Forest projects and businesses**. This component had a more practical connotation as it consisted in providing technical and financial support to start-up micro-entrepreneurial projects or strengthening already existing small-businesses related to sustainable production of timber and non-timber forest products and eco-tourism (including legal approval of the newly formed or already established business entities) as well as in supporting the adoption of agroforestry and good environmental practices for climate change mitigation and adaptation (*e.g.*, agroforestry modules, plant nurseries, firewood saving stoves).

Based on the above, the logic of the project is such that it is expected to have impacts at two different levels:

- At the **household/community level**: the project aims at reducing households' poverty mainly through increased income and greater diversification of economic activities (*i.e.*, new income sources and employment opportunities) related to sustainable production of timber and non-timber forest products as well as social capital formation/strengthening;
- At the **environmental level**: the project aims at contributing to climate change mitigation and adaptation mainly through the adoption of agroforestry and good environmental practices as well as through the conservation and valorisation of forest natural resources that can help avoid deforestation and reduce CO2 emissions.

Once project beneficiaries and control households are identified, impacts can be assessed on indicators of the above. It is also important, however, to identify and measure the mechanisms through which these results are expected to be achieved. The project’s theory of change summarized in Figure 1, shows how the inputs provided and activities implemented through the project are associated to particular outputs. The expected outcomes implied by project's outputs, and which will lead to the expected final impacts, are distinguished by the two levels DECOFOS is supposed to have had influence on: household/community and the environment.

The project is therefore expected to have a positive impact on the livelihood of beneficiaries by reducing poverty as well as on environmental conditions of the targeted areas through climate change adaptation and mitigation initiatives. The first impact is supposed to be achieved thanks to the fact that beneficiary households are expected to increase their income and reduce income variability by diversifying their economic activities (and therefore income sources), increase their products and profits and benefit from more employment opportunities created for their members. This logic is seen in a more dynamic local economy context where economic actors have better technical and managerial capacities, women are empowered and social relationships as well as organizational networks and formal associativity are stronger. All of the above is meant to happen through the delivery and implementation of specific inputs and activities such as technical training and workshops, distribution of production inputs, equipment and technologies, business mentoring and assistance; these, in turn will allow for the creation and formalization of new businesses and investment plans. Similarly, the impact at the environmental level is expected to be achieved thanks to the sustainable development and natural resource conservation of forest areas and avoided deforestation which lead to reduced CO2 emissions; in addition, land titling and land protection system combined with capacity development and climate change awareness will lead to the adoption of good agricultural and environmental practices, agroforestry, reforestation and restoration of degraded forest land.

Figure 1: DECOFOS theory of change

2.2 Project coverage and targeting

DECOFOS target population residing in marginalized forest areas in Oaxaca, Chiapas and Campeche, is represented by *ejidatarios* who are members of rural communities and *ejidos* with land rights and involved in collective decisions about land administration and use, the group of *posesionarios* who do not have any rights on the land they use and collectively administer, as well as the *avecindados*, individuals residing on common land without any land rights. The project covered a total of 79 municipalities: 47 (out of a total of 570) in Oaxaca, 21 (out of a total of 118) in Chiapas, and 11 (all) in Campeche. Figure 2 illustrates the geographic coverage of the project.[4]

Both Component 1 and 2 were implemented through a demand-driven process[5]. As a first step, project awareness campaigns were promoted in eligible areas followed by an advertisement campaign of project's call for proposals via different communication medias (radio, newspapers, leaflets, etc.). At this point, interested community/*ejido* members (including those without land rights) from eligible areas united themselves into groups and, with the assistance of a technical advisor,[6] prepared the legal and technical documentation needed to submit a formal request to obtain project's support for one or more specific type of activity[7]. Table 1 summarizes the type of supports that have been requested and granted throughout the duration of the project by project's component.

The selection process for project participation was done at different levels once the eligible areas had been identified and the project promoted and offered in the various communities and *ejidos* within the eligible areas where degradation and poverty levels were present as per project requirement. In particular, project areas were identified based on the following criteria: (*i*) high and very high marginalized areas, (*ii*) presence of communities without ongoing forest management programs, (*iii*) areas with limited attention from institutions and governmental programs (especially forest programs such as "*Procymaf*" and "*Proárbol*"), (*iv*) areas characterized by the presence of spots with high biodiversity and potential to provide goods and services, (*v*) areas with scarcity of natural resources but with potential to develop products that can satisfy the demand of local industries (*e.g.*, plantations) and restore the wood mass. As a result of interest shown by the various *ejidos*/communities and of the evaluability and validity of the development plans they proposed, participant *ejidos* and communities were selected. Obviously, not in all of the eligible municipalities there existed communities and *ejidos* that asked or obtained to participate to the project. Consequently, it is possible that some of the eligible municipalities did not participate to the project at all; likewise, within participant municipalities, not all *ejidos* or communities participated to the project and in turn it frequently happened that in one specific (eligible) community/*ejido* only part (those willing to) and not all of the *comuneros/ejidatarios* participated to the project.

The DECOFOS project was approved September 15th, 2009 and became effective March 23rd, 2011. The implementation of the project lasted 5 years and it was completed March the 31st, 2016 (closing date was September 30th, 2016). The total cost of the project was US$18.5 million with a contribution from IFAD of about US$5 million and a donation from the Global Environment Facility (GEF) of US$5 million. The rest was financed by the Government of Mexico (US$7 million) and by contributions of beneficiaries (US$1.5 million). The *Comisión Nacional Forestal* (CONAFOR) was

[4] The complete list of eligible municipalities is available in Table A1 in the appendix.

[5] For a graphic description see Figure A1 in the appendix.

[6] It has to be noted that in order for a technical proposal to be valid and considered for application this had to be developed with the assistance of (and signed by) a technical advisor to be chosen from an official list of accredited professionals provided by CONAFOR.

[7] In the appendix, Table A2 summarizes the type of supports that have been requested and granted throughout the duration of the project by project's component.

the lead implementing agency for DECOFOS through its state delegations and the Project Management Unit (PMU).

Figure 2: DECOFOS project areas

Source: IFAD

In addition to the intended impacts, there are several possible secondary (unintended) effects in the implementation of the project:

- Increased input purchases: in order to sustain the new micro-businesses started-up with the project and agroforestry production;
- Increased associativity and inclusion of people without land rights into community's economic activities: thanks to the project the *avecindados* are recognized with an active role within the economic life of the communities and start to be involved in it;
- Reduction of illegal exploitation of forest areas: thanks to the project, awareness is raised with respect to the potential economic and environmental value of forest natural resources, which lead to reduced illegal extraction of timber and non-timber forest products;
- Increased use and extraction of non-timber forest products;
- Increased access to financial resources thanks to well thought business development plans but also to formal land titling.

The main spillover effects are expected to be the following:

- Benefits entailed by the project in terms of new businesses initiated and employment opportunities created are also transmitted to non-participants, particularly to non-participant community members within participant communities;
- Similarly, global benefits can be generated by the adoption of agroforestry and good environmental practices such as increased CO2 sequestration and increased biodiversity.

2.3 Research questions

Keeping the project's theory of change and its target population in mind, we conducted an impact assessment with the aim of answering the following questions:

- Did forest and vegetation area increase (compared to the baseline) thanks to increase in reforestation and adoption of natural resource management practices in project's communities/*ejidos*?
- Did the project translates into higher use of land for agroforestry purposes thanks to legal permits and land titling?
- Did the project translate into higher and more diversified income sources for beneficiaries through the use of forest resources and common land and through creation of new micro-enterprises and small business opportunities?
- Did the project translate into higher employment rates both at the beneficiary household and community level through the creation of new micro-enterprises and small business opportunities?
- Did the project translate into higher and stronger social capital through more participation in associations/organizations/groups (both in terms of participants as well as frequency of events)?
- Did the project confer a participative role to female and young beneficiary household members?
- Did the negative effects of climatic variability and extreme weather events decrease thanks to agroforestry as well as the adoption of other natural resource management?

3. Impact assessment design: Data and methodology

3.1 Data

With the purpose of providing valid answers to the above mentioned research questions and taking into account the project design, this ex-post impact assessment relies on a quasi-experimental mixed method approach. Employing both qualitative and quantitative data, the ultimate goal is to create an appropriate counterfactual to be compared to those who received the intervention, given the impossibility of comparing the situation with and without the project for this same unit of analysis.

Indeed, when evaluating the impact of a project the most compelling issue is to find a group of units which did not receive the intervention under analysis (control group, henceforth), but that is comparable to the sample of beneficiaries (treatment group, henceforth) in terms of both observable and unobservable pre-project characteristics. Furthermore, when the targeting is not randomly assigned, in order to have a valid counterfactual, the distribution of its observable characteristics has to be similar to the one of the treatment group, in addition to not being related with treatment assignment nor its impact indicators.

In the case of DECOFOS, although the project was assigned at community level, individual households could choose to be part of the project depending on their willingness to participate in and cash contribute to the project. Consequently, the evaluation methodology must address two rounds of selection bias: first, the targeted selection of communities, and second, the self-selection of community members. Thus, both the sampling strategy as well as the econometric approach were chosen with this challenge in mind.

Due to the ex-post nature of this impact assessment, and the fact that the project took track of all the financial supports provided as well as of their beneficiaries, the identification of the **treatment group** has been based on the list of communities/*ejidos* by type of financial support provided by the Project Management Unit (PMU). As a first step beneficiary communities and *ejidos* have been identified by type of intervention and excluding those that did not obtain any intervention except

basic training (which we classify here as low impact activities). Secondly, for these communities a random sample of treatment households has been selected from the complete list of direct beneficiaries (name, surname and address) provided by the *comisarios ejidales* through the PMU.

For the identification of the **control group**, the selection process for the impact assessment sought to mimic to the greater extent possible the process and mechanisms applied for the selection of project's beneficiaries among community groups inside eligible municipalities. At the start of the process, there were a number of eligible but non-beneficiary *ejidos* in the project areas, allowing for control communities to be selected. Within this list two types of communities/*ejidos* the following have been identified: (*i*) communities/*ejidos* that applied for project intervention but were excluded from the selection process and, (*ii*) communities/*ejidos* that did not apply for any project intervention. Given the fact that the former group has been excluded from the selection process because, even though eligible, their technical proposal did not comply with the legal requirements, it cannot be considered as a valid control group. For the latter case, in order to understand why these communities (even if eligible) did not apply to participate to the project, meetings with the technical advisors accredited by CONAFOR and the CONAFOR state delegations have been held in each state. As already mentioned, the technical advisors played a crucial role in the whole selection process since, in order for a technical proposal to be valid and considered for application this had to be developed with the assistance of (and signed by) a technical advisor to be chosen from an official list of accredited professionals (about 25 per state) provided by CONAFOR. Moreover, part of the advertisement campaign of the DECOFOS project in the eligible municipalities was also their responsibility. However, the technical advisors were allowed to manage a maximum of 8 proposals each which may imply that a number of potential beneficiary communities/*ejidos*[8] have been excluded from the project due to limit reached by technical advisor and by project dimension and therefore exogenous to project criteria[9] thus constituting a valid potential control group.

Once the complete list of potential control communities/*ejidos* has been compiled, a propensity score matching approach using data from the National Institue of Statiscis (INEGI) from the *Censos Ejidal* and using variables that proxy the criteria used for selection of villages by the projects[10] was implemented. Applying this methodology, the probability of each community to be selected and to self-select into the project was predicted using a linear probability model. The generated probabilities were then used to apply a nearest-neighbour (NN) algorithm to match each treatment community to the closest three control communities in terms of propensity score.

While the Propensity Score Matching approach solves the self-selection issue based on observables characteristics, it does not control for unobservable. For this reason, a validation procedure was conducted through expert consultation.

In order to avoid selection on unobservable characteristics, the matched villages have been validated through ad hoc meetings organized in each project state with the PMU, the CONAFOR state delegations, and the technical advisors. These meetings had the objective to identify among the full

[8] Those who, having been informed about the project or having had the support of the technical advisor, could have applied for and be granted financial support to implement high-expected-impact activities.

9 Exogenous reasons may include for example distance and logistics from technical advisors, network of the technical advisors, better relationships with some Comisariados de Bienes Comunales/Comisariados Ejidales, etc. The *Comisariado de Bienes Comunales/Comisariado Ejidal* is the authority in charge of executing and enforcing the decisions taken by the *Asamblea* as well as representing and managing the administration of the community/*ejido*. It also legally represents the *núcleo agrario* in front of third parties based on the agreements taken by the legally constituted *Asamblea*. It is composed by the president, the secretary and the treasurer.

[10] Namely population, number of *eijodatarios*, share of arable land, share of forest, share of degraded area, road, infrastructure, poverty, income sources, etc.

list of potential controls matched with treated villages those communities/ejidos that are as similar as possible to the treated.

Once the selection of treated and control villages had been completed, after matching and validation with groups of local expert, a second level of sampling at villages level was conducted for households to interview.

In the treated villages, participant households were selected from a list provided by the project implementers. However, since about 20-25% of households in each village did not participate in the project, a group of non-participants in participant households within participant villages is also selected randomly after excluding direct beneficiaries, and referred to as indirect beneficiaries. As such for the **indirect beneficiary group** in each treated village, we selected about 25% of the total sampled households from the list of inhabitants that did not directly participate to the project and that were used to check for spillover effects.

As part of this impact assessment, a community survey was conducted with a selection of community leaders in every survey location. The initial sample comprised of a total of 110 communities/*ejidos* (half treatment and half control) while the total estimated sample comprises of 2,200 households. Ultimately, 108 *ejidos* were visited and a total sample of 2,230 households were interviewed. Table 1 describes the distribution of the target as well as the final sample of communities/*ejidos* and households by state.

Table 1. Number of treated and control Communities/*Ejidos* and Households by state

Communities/*Ejidos*	Treatment		Control	
	Target	Completed	Target	Completed
Campeche	20	20	20	20
Chiapas	20	20	20	20
Oaxaca	15	14	15	15
TOTAL	**55**	**54**	**55**	**54**
Households	**Treatment**		**Control**	
	Target	**Completed**	**Target**	**Completed**
Campeche	400	408	400	403
Chiapas	400	418	400	399
Oaxaca	300	302	300	300
TOTAL	**1,100**	**1,128**	**1,100**	**1,102**

After the dataset has been collected, a propensity score matching (PSM) procedure was conducted at household level in order to ensure stronger comparability between households in treated and control villages. This kind of analysis based on a linear probability model allows to predict each households' probability to be selected and to self-select into the project, using main variables that act as indicators or proxies of each determining factor identified with qualitative research. We choose nearest-neighbour algorithm to match on the propensity score. Using five nearest neighbours and a *caliper* of 0.01, the model leaves three households off of the common support. Figures A2 and A3 of the appendix show matching results using the pooled control group. Both graphs confirm the fact that a

good sampling strategy has been implemented in the selection of the control group to be used as an appropriate counterfactual. In particular, the kernel plot for probability of treatment (Figure 2 of the Appendix) shows the correspondence between treatment and control groups confirming the common support assumption. Furthermore, figure 3 on the relative bias between unmatched and matched groups, shows that matching considerably reduces the bias across nearly all matching covariates.

The following table 2, provides descriptive statistics of matching variables for treatment and control households before and after the matching. The two groups result to be comparable on most of the observable characteristics used for matching and which show no significant differences. On those characteristics that show significant differences the matching approach does a very good job at reducing the bias.

Table 2. Descriptive statistics of matching variables for treatment and control households before and after matching

	Before matching (N=855/1375)				After matching (N=817/1302)				Reduction in bias (%)
	Treat. Mean/ SE	Control Mean/ SE	p-value	Bias	Treat. Mean/ SE	Control Mean/ SE	p-value	Bias	
Number of household members	4.04	3.92	0.148	4.77	4.03	4.02	0.93	0.43	90.98
	0.06	0.05	.	.	0.06	0.06	.	.	.
Households with female head (%)	11.46	15.05	0.016**	6.66	11.75	10.71	0.49	3.11	53.34
	1.09	0.96	.	.	1.13	0.90	.	.	.
Age of household head (years)	51.80	48.02	0.000***	23.22	51.51	51.61	0.88	0.73	96.88
	0.46	0.40	.	.	0.47	0.42	.	.	.
Dependency ratio (below 14 years and above 14 years)	0.73	0.74	0.666	1.26	0.73	0.73	0.91	0.54	56.85
	0.02	0.02	.	.	0.03	0.02	.	.	.
Households with married head (%)	85.85	83.64	0.161	4.05	85.92	86.94	0.54	2.87	29.26
	1.19	1.00	.	.	1.22	0.98	.	.	.
Number of years of education of household head	5.20	5.46	0.116	5.93	5.25	5.18	0.70	1.93	67.51
	0.13	0.11	.	.	0.13	0.12	.	.	.
Households with indigenous head (%)	53.22	44.15	0.000***	15.27	51.77	50.18	0.52	3.20	79.08
	1.71	1.34	.	.	1.75	1.45	.	.	.
Household head is *posesionario* (%)	15.91	19.85	0.019**	8.37	16.16	16.16	1.00	0.02	99.78
	1.25	1.08	.	.	1.29	1.07	.	.	.
Households with catholic head (%)	56.49	52.51	0.067*	5.85	56.67	56.78	0.96	0.23	96.08
	1.70	1.35	.	.	1.73	1.44	.	.	.
Households that have access to piped water (%)	85.61	86.11	0.744	4.37	85.43	85.94	0.78	1.46	66.54
	1.20	0.93	.	.	1.23	1.01	.	.	.
Households with dwelling walls of good quality (%)	49.01	51.13	0.330	3.87	49.45	48.94	0.84	1.03	73.42
	1.71	1.35	.	.	1.75	1.45	.	.	.
Households that have access to private toilet facility (%)	65.73	64.15	0.446	2.54	65.73	65.29	0.86	0.91	64.22
	1.62	1.29	.	.	1.66	1.38	.	.	.
Households that use gas to cook (%)	10.41	11.71	0.344	2.47	10.89	11.03	0.93	0.43	82.72
	1.04	0.87	.	.	1.09	0.91	.	.	.

Number of dwelling rooms	2.57	2.41	0.002***	10.31	2.54	2.58	0.59	2.82	72.69
	0.04	0.03	.	.	0.04	0.04	.	.	.
Households participating in one or more groups until 2011 (%)	20.23	13.89	0.000***	10.35	17.50	17.59	0.96	0.25	97.63
	1.37	0.93	.	.	1.33	1.11	.	.	.
Community had facility at baseline: Transport (%)	51.46	47.31	0.057*	7.05	51.53	54.07	0.31	5.09	27.91
	1.71	1.36	.	.	1.75	1.45	.	.	.
Community had facility at baseline: Market (%)	11.11	10.77	0.805	1.02	11.38	12.25	0.60	2.75	-168.57
	1.08	0.84	.	.	1.11	0.95	.	.	.
Community had facility at baseline: Road (%)	63.27	49.30	0.000***	25.07	62.42	62.56	0.95	0.28	98.88
	1.65	1.36	.	.	1.70	1.41	.	.	

3.2 Questionnaire and impact indicators

The main data collection instruments for this impact assessment are household and community questionnaires. Both surveys were supposed to be administered by September 2017, but due to unforeseen circumstances such as the earthquakes that struck Mexico's southern states in September 2017, the data collection has been completed between December 2017 and January 2018. The information collected refers to the twelve months preceding the survey implementation. In particular, data on crop production take as reference period the last completed agricultural cycle namely starting from June 2016 to July 2017. The household questionnaire collected information at household level on a number of socio-economic characteristics, land and asset ownership, agricultural, agroforestry and livestock production and marketing, shocks and risk management strategies, dietary diversity and food security, access to financial services, social capital, participations to organizations and networks. The type of data collected through the community questionnaire included access to infrastructure and basic services, main economic activities, social capital and collective action, organizations and networks.

This very rich set of information collected was used to construct outcome and impact indicators to answer the posed research questions and assess the impact of the DECOFOS project on the population of interest. In particular, we focus on estimating project impact on five sets of indicators which are described in the next section and respond to the causal pathways that are expected to be activated by the project as illustrated in its theory of change in Figure 1.

A variety of impact indicators conceptualized in five groups, has been carefully analysed as part of this impact assessment. We first analyse indicators related to environmental benefits and resilience, we then discuss economic mobility to then move to measuring food insecurity (Ballard et al., 2013), and diet diversity (FAO, 2011), to conclude with social capital aspects and access to market. The analysis also includes the main group of indicators measuring income sources including use of natural resources and forestry, business activities as well as crop income. A list of these indicators as well as a description of their construction is included in the table A3 of the appendix.

3.3 Impact estimation

As a first step, we conduct a nearest-neighbour matching exercise to ensure the two samples share sufficient common support and are well-balanced on the matching covariates listed in Table 2. We then use two methods to estimate average treatment effect on the treated (ATET) using the propensity score: inverse probability weighting (IPW), and inverse probability weighting with regression adjustment (IPWRA).

The ATET is the average treatment effect among project participants and can be written as follows:

$$ATET = E(y_1 - y_0 \mid T = 1)$$

Where $y_1 - y_0$ is the difference between the outcome attributable to the intervention and the outcome that the same household would have if it did not participate. Of course, as we are unable to observe what would have happened to a participant household without the project, we instead estimate counterfactual using the two non-experimental methods mentioned above.

Our principal ATET estimates are reported using the IPW estimator (Imbens, 2000; Hirano et al., 2003; Busso et al., 2009a,b; Wooldridge, 2010), as it is an intuitive method which performs well when the samples share a strong common support. As a robustness check, we then compare the results to others obtained using IPWRA. Given the robusteness of the results across the two methods we only report IPW results.[11]

With the IPW estimator, average treatment effects are estimated following a two-step approach:

1. We specify a treatment model to estimate the probability of each household receiving the project (*i.e.*, the household's propensity score), and calculate a weight for each household as the inverse of its propensity score.
2. We then use the weights to compute weighted averages of the outcomes for each group, where the average treatment effect is the difference between these weighted averages.

Results rely on the assumption that the treatment model includes all relevant determinants of project participation which also influence outcomes, such that after weighting, treatment is independent of the outcomes conditional on these covariates.

Estimations are clustered at the village level, in accordance with the sampling strategy (Abadie et al., 2017).

4. Profile of the project area and sample

The DECOFOS activities implemented differ across the states in which they have been implemented: Oaxaca, Campeche and Chiapas.

This impact assessment focuses on some and not all of the activities implemented with the financial support granted by the project to selected participants. This choice is based on the fact that we can distinguish between activities for which we expect to have some impact and others for which we expect low or no impacts on project's outcomes. Table 3 describes the above mentioned types of intervention classified based on the expected impact by state[12].

Based on results of some key informant interviews and feedback received by key project staff and beneficiaries during our scoping mission in the field, three scenarios with different probability of occurrence naturally emerged:

1. Communities/*ejidos* that benefited only from low-expected-impact activities (20%);
2. Communities/*ejidos* that benefited only from high-expected-impact activities (30%);
3. Communities/*ejidos* that benefited from both types of activities: low-expected-impact as well as high-expected-impact activities (50%).

[11] Results using IPWRA estimators are available upon request, but are robust and consistent with results reported here.
[12] It is important to clarify that low impact activities are mainly linked to capacity building/training without any other type of intervention.

Table 3. Beneficiaries of activities based on expected impact by state.

Activity	CAMPECHE	CHIAPAS	OAXACA
High and (Low + High) impact activity	**%**	**%**	**%**
Modulos Agroforestales	34.66	3.1	21.21
Proyectos de transferencia de tecnología	14.34	16.72	15.15
Viveros comunitarios	8.37	5.26	6.06
Ejecución de Proyectos de Microempresas Rurales	7.17	24.15	6.06
Constitución y registro legal de microempresas rurales	7.57	7.74	4.24
Total	**72.11**	**56.97**	**52.72**

Due to the above, we decided to exclude from this impact assessment communities/*ejidos* receiving activities with low or negligible impacts such as awareness raising/training.

The sample has been constructed in order to respect as much as possible the different proportions of beneficiaries by state and municipality.

The heterogeneity across states of topography, agro-ecology, socio-economic setting, population, presence of indigenous groups, average land size represents a valid motivation to conduct the impact assessment distinguishing by state, in addition to overall project's impacts.

5. Results

Following the project theory of change, this section presents results on the outcomes and impacts of DECOFOS on its direct participants versus pure control households (*i.e.*, non-participants in non-participant communities) for the entire group of project direct beneficiaries, as well as for the same beneficiaries against control disaggregated by states.

All impact estimates presented in the sub-sections that follow are based on IPW estimator and are reported in absolute values. As the control group represents how beneficiary households would have been in the absence of the project, the mean value of the control group is reported (also in absolute values) next to the impact estimate in all tables and for all indicators. This facilitates interpretation of results as the ratio of the impact estimates to the mean value of the control group will represent the percentage increase/decrease in the given indicator attributable to the project. The total number of observations is reported for each outcome variable. The number of observations can vary across variables due to missing observations for some of the additional indicators reported to enrich the analysis. It is also important to specify that impact estimates reported represent the average treatment effect on the treated (ATET), and are obtained by comparing the direct beneficiary group against the control group (non-participants in non-participant communities).

Impact indicators are reported in four groups[13]. Given the emphasis of the project on environment related outcomes, we first examine those that measure impacts on natural resources using the

[13] Although not related to project components and actitivties implemented in the three states, further results on crop yield and input use are reported in table A4 in the Appendix.

Normalized Difference Vegetation Index (NDVI) at the end of the project, access to common land and use of permits to access land which should be a good proxy for sustainable use of land and natural resources. We then report results on economic mobility using total household net income, income diversification, asset indices and poverty and we look into more details into use of common resources and income from business enterprises which were the focus of the project. Finally, we examine other outcome indicators related to diet diversity (FAO, 2011), experience of food insecurity (Ballard et al., 2013). The analysis follows with market access indicators which are combined with a range of indicators related to social capital and gender[14].

5.1 Impacts of DECOFOS

We first start by presenting results on indicators related to environmental impacts and to resilience and climate related shocks. As indicated earlier the first indicator we report in table 4 is the NDVI which is a remote sensing indicator that assesses the live green vegetation of the targeted areas which, in our case, are treatment and control communities/*ejidos*. As such, the NDVI, is a proxy to indicate the change in vegetation between treated and control areas considering that it has been checked at baseline and forest area used as a matching variable at community/*ejidos*' level. Results reported show that the NDVI has significantly increased in treated areas as compared to control, indicating that the efforts made with reforestation and agroforestry activities were successful in increasing green mass and therefore in mitigation of CO2 emissions. Whereas this is particularly true for Campeche, where the focus of the project was precisely on strengthening the sustainable use of natural resources and on increasing forestry and agroforestry, and for Oaxaca where the various project components were equally distributed, a decrease is reported in the case of Chiapas where, however, the vast majority of project intervention focussed on starting and expanding business enterprises. It is also important to note that precipitation coefficient is not significantly different across the groups and across the states, both in the long term as well as for the years 2016/2017, therefore changes in precipitation would not justify a change in vegetation.

Table 4. Results on indicators of environmental impacts and resilience

	Whole sample			Campeche		Chiapas		Oaxaca	
	ATET	**Control mean**	**N**	**ATET**	**Control mean**	**ATET**	**Control mean**	**ATET**	**Control mean**
Normalized difference vegetation index (NDVI)	0.017***	0.639	1 934	0.037***	0.635	-0.011***	0.656	0.018***	0.633
Precipitation Seasonality (Coefficient of Variation)	0.376	90.224	1 934	-2.051	84.483	2.477	94.937	1.858	90.685
Ability to recover from shocks	0.171***	2.204	1 238	0.073***	2.455	0.169***	2.100	0.262***	2.007
Households affected by climatic shocks since 2011 (%)	-6.203***	59.255	1 934	-3.221***	80.928	-1.331***	37.549	-7.724***	49.759
Households affected by drought (%)	-7.491***	45.520	1 934	-1.336***	69.807	-6.471***	25.702	-7.087***	28.768
Household is required to have permission to exploit common land	7.329***	8.186	1 634	6.646***	3.518	13.786***	9.591	1.437***	9.183

note: .01 - ***; .05 - **; .1 - *;

[14] Descriptive statistics on main impact indicators for beneficiary and control groups are reported in table A5 in the Appendix.

We also report results on resilience which show that project beneficiaries are significantly more able to recover from shocks, but also that beneficiaries have been less affected by drought and other climatic shocks. Given we control for climatic variability and found no differences across the groups on drought or other climatic variation, this may indicate that the adoption of agroforestry practices and the increase in natural vegetation has been effective in protecting the areas from shocks and in increasing resilience. We also check for impacts on earthquake and found no significant differences across the groups.

Last but not least, it is also important to note that project beneficiaries are significantly more requested to use common land which includes forests and natural resources through the use of legal permits which is considered a proxy for sustainable use of forest and common natural resources and which was one of the focus of the project.

Economic mobility indicators are reported in table 5. Although beneficiary households have higher net household income both overall as well as across the three states, average income values are not significantly different between beneficiaries and control group. On the other hand, the gross household income is also higher, and this time significantly, for the entire group of direct project beneficiaries as compared to the control group as well as when the value is disaggregated by State. To support positive impacts on economic mobility, we also find significantly and positive differences in mean values on the increase of both total assets and particularly of productive assets, possibly indicating the investments being made on small business enterprises and on other productive assets. Similarly, a significant reduction in the probability of being poor is reported among the 60th percentile of the population using an asset-based poverty line. On economic mobility it is also interesting to note a significant increase in income diversification which is true also for Chiapas and Campeche, where respectively the project focussed on starting up and expanding business enterprises and on strengthening the use of common natural resources and forest resources respectively, but not for Oaxaca.

Table 5. Results on indicators of economic mobility

	Whole sample			Campeche		Chiapas		Oaxaca	
	ATET	**Control mean**	**N**	**ATET**	**Control mean**	**ATET**	**Control mean**	**ATET**	**Control mean**
Total net household income (USD)	227.762	1 038.798	1 919	55.442	1 047.286	632.859	1 171.869	34.720	716.920
Total gross household income (USD)	243.422**	1 102.319	1 919	194.207**	1 404.669	474.667**	1 229.833	218.286**	642.975
Income diversification (Number of income sources)	0.092*	2.123	1 919	0.339*	1.932	0.076*	2.277	-0.224*	2.193
Durable assets index	0.004	0.451	1 919	0.007	0.509	0.011	0.432	0.005	0.385
Productive assets index	0.106**	0.260	1 919	0.378**	0.435	0.066**	0.040	0.007**	0.158
Total assets index	0.029**	0.189	1 919	0.103**	0.252	0.021**	0.126	0.003**	0.145
Households below asset-based poverty line, 40th percentile (%)	-1.160	35.521	1 919	-2.806	13.316	-6.271	45.694	0.218	59.517
Households below asset-based poverty line, 60th percentile (%)	-4.144*	56.158	1 919	-7.326*	28.982	-9.876*	70.774	-4.936*	85.909

To explore the mechanisms of these high-level impacts, we examine project effects first on the key types of income-generating activities that were the focus of the present project, namely income from forest/agroforestry resources and access to common land and income from business enterprise. We also look at income from crop production even though this was not the main focus of the project. For the overall sample, it appears that net household income is mainly driven by changes in the income-generating potential of natural resources from common land and business activities related to use of common land resources. This is particularly true in Campeche, where beneficiary households can expect an average of about 52USD more per year from the sales of these resources. In addition, there is also a reported increase in the number of parcel used, likely linked to legal permits and acquisition of previously wildland parcels through the project, and now managed through sustainable forestry approaches. The number of parcels as well as the number of households exploiting natural resources is significantly increased in Campeche and Chiapas, whereas it is reduced in Oaxaca. As a matter of fact income from natural resources in Oaxaca decreases.

On the other hand, when we look at income from business activities, we find significant increases across the sample and particularly in Chiapas where most of the project intervention concentrated precisely on this component. Last but not least we also look at income coming from crop production and find that whereas there has been an increase in the types of crops produced, across the sample and across the states with the exception of Oaxaca where there has been a decrease in the diversity of crops grown per land allocation; income from crop production is unsurprisingly not significantly different across the three states, with a negative value in the case of Campeche.

Table 6. Results on indicators on income composition

	Whole Sample			Campeche		Chiapas		Oaxaca	
	ATET	Control mean	N	ATET	Control mean	ATET	Control mean	ATET	Control mean
Households exploiting natural resources from common land (%)	6.538**	50.959	1 634	18.133**	49.408	5.337**	52.455	-7.858**	47.681
Income from sales of natural resources from common land (USD)	21.185***	3.033	1 634	52.450***	6.016	4.284***	1.536	-0.319***	0.534
Income from sales of tree resources (USD)	3.492	1.403	1 634	9.626	0.665	1.440	1.853	-0.825	0.825
Parcels operated by the household (Nr.)	0.199***	1.780	1 634	0.254***	1.461	0.491***	2.237	-0.194***	1.144
Business activities sell products from common land (%)	0.013*	0.014	1 934	0.020*	0.012	0.022*	0.010	-0.008*	0.021
Households entered into new business since 2011 (%)	0.022*	0.056	1 934	0.008*	0.091	0.042*	0.035	0.016*	0.033
Net income from business activities (USD)	78.113*	50.373	1 934	46.733*	68.147	165.491*	21.883	37.881*	28.213
Net income from crops (USD)	-37.474	686.504	1 619	-379.356	825.984	336.045	707.153	41.115	324.921
Gini-Simpson index of crop diversification	0.044**	0.243	1 634	0.070**	0.257	0.077**	0.226	-0.052**	0.269

As a fourth step we look, in table 7, at impacts on food diversity and food security indicators, where we observe a positive result in that the food insecurity indicator determined through the Food Insecurity Experience Scale (FIES) is significantly reduced across the sample and across the three states. Similarly, we find positive and significant impact on the number of meals consumed daily in the household, in turn reducing the level of food insecurity experienced by the adult members, with

the exception of Oaxaca where the average number of meals per day is reduced, although it is the highest rate of the entire sample. on the other hand, dietary diversity score is not significantly different across the sample and across the three states, but it must be said that its composition indicates a rather diversified diet across the entire sample as well as in each state.

Table 7. Results on indicators of food diversity, food security and resilience

	Whole Sample			Campeche		Chiapas		Oaxaca	
	ATET	Control mean	N	ATET	Control mean	ATET	Control mean	ATET	Control mean
Food Insecurity Experience Scale score for Adults	-0.200**	1.786	1 934	-0.141**	2.051	-0.145**	1.555	-0.514**	1.895
Food Insecurity Experience Scale score for Children	-0.050	0.552	1 934	0.021	0.673	-0.072	0.428	-0.063	0.501
Household Dietary Diversity Score (HDDS), weekly	-0.143	9.835	1 934	-0.438	10.323	0.062	9.663	-0.080	9.461
Number of meals per day consumed by the household	0.068***	2.635	1 910	0.102***	2.594	0.094***	2.633	-0.071***	2.751

Finally, results presented in Table 8 focus on market access, gender and social capital indicators. No strong results are found with regard to this last group of indicators with the exception of new transport system developed after the start of the project which is significant and positive for the entire sample as well as for Campeche and Oaxaca but not for Chiapas, where, however, the average value is much higher than in the other states. The other variables used to proxy direct sales of output to final consumers, although positive is not significantly different whereas the opposite holds true for selling to traders or intermediaries: the value is negative but not significant. Similarly, with regard to social capital and group formation we found that participant villages are more likely to have groups and particularly women's groups formed than non-participants but no other significant results are found on other social capital variables nor on youth participation which resulted being so low that non-sufficient observations were collected to be able to derive any meaningful statistics.

Table 8. Results on indicators on market access, social capital and gender

	Whole sample			Campeche		Chiapas		Oaxaca	
	ATET	Control mean	N	ATET	Control mean	ATET	Control mean	ATET	Control mean
Community has new transport system since baseline	5.087***	8.997	1 934	6.664***	7.667	-9.514***	15.925	17.341***	6.995
Households with business activities selling products to final consumers (%)	1.262	6.015	1 934	0.611	8.306	2.315	5.377	-0.127	4.552
Households with business activities selling products to traders (%)	-0.802	3.385	1 934	0.535	4.242	-0.928	1.889	0.539	1.231
Households buying seeds and other ag input from relatives and friends (%)	3.137	15.685	1 650	0.150	28.218	2.710	8.630	-4.449	20.795
Grupo de mujeres in the community	0.045**	0.223	1 934	0.205**	0.315	0.176**	0.032	-0.166**	0.166
At least one group exists in the community	0.119***	0.413	1 934	0.327***	0.367	0.049***	0.448	0.070***	0.284

Part. in farmers groups since 2011 (yes=1)	0.002	0.013	1 934	0.014	0.005	0.003	0.010	-0.004	0.017
Part. in women groups since 2011 (yes=1)	0.001	0.011	1 934	-0.014	0.030	0.003	0.000	0.017	0.001
Groups in which HH participates since 2011 (Nr.)	0.022	0.077	1 934	0.048	0.070	-0.004	0.126	0.008	0.037
Households with members with leading positions in farmer groups (%)	-0.343	0.813	1 934	0.584	0.053	-0.713	1.034	0.187	0.256

Finally it is worth noting that we also tried the analysis comparing indirect beneficiaries to direct beneficiaries as well as pooling indirect beneficiaries with control against direct beneficiaries and found no-spillover effects and exactly the same results as for the control group and therefore they are not reported here. The only difference worth noting, is a different composition of their income which is more largely dependent on agriculture and exploit less of common resources and forestry as well as other business opportunities.

Last but not least it is also important to note that no significant impacts are reported in terms of number of *avecindados* participating to the project or having access to land, differences in number of *avecindados* are not significantly different also because the number of observations reported have been too low to show any significant difference. Similar results apply to migration where we found no significant difference and too few observations to be able to report meaningful statistics.

6. Conclusions

The DECOFOS project represents a rather innovative and interesting type of intervention which tried to merge environmental benefits with private ones. The project in its practical implementation tried to represent and reflect the different topographical, agro-ecological and socio-economic differences of the three southern states involved, namely Chiapas, Campeche and Oaxaca. Results reported in the present Impact Assessment are perfectly aligned to the different strength and emphasis the project has put on the different components. More in particular, whereas the largest amount of project intervention was invested on the increase of land use brought into agro-forestry or forest practices in the state of Campeche, a largest portion was instead invested on facilitating the starting up or expansion of business enterprises in the state of Chiapas. On the other hand, in Oaxaca investments were spent more on awareness raising and training; moreover of the amount spent on the two components above mentioned, namely sustainable use of natural resource and strengthening business enterprises, were equally shared resulting in a rather scattered type of intervention.

Overall, the project indicates successful results with regard to environmental benefits achieved as indicated in the increase of the NDVI as well as in the increase of permits needed to access common natural resources and increase of parcels used which are proxies for sustainable use of natural resources. This is true across the sample but more so in the state of Campeche where emphasis on this component was stronger. This is directly reflected also in the increase of income coming from access to natural resources, use of trees and other common land resources being sold. Similarly, project beneficiaries seem to be more resilient to shocks and particularly to climatic shocks and also less affected by drought and other climatic shocks in terms of negative impacts whereas no differences are reported when using climatic variables suggesting indeed that project participants are more resilient to climatic shocks and anomalies. On the other hand, in the state of Chiapas more

significant increase in income comes from business enterprise even though amounts are not extremely high. However, on a more general level this is also reflected in the increase of total assets, and particularly of productive assets, which are also a reflection of investments in business enterprises as well as in reduction in the probability of being poor among the 60th percentile of the population. An increase in economic mobility and wellbeing is also reported through looking at nutrition indicators and food insecurity whereby the former indicates an increase in the number of meals per day and the latter a reduction of food insecurity. The composition of diet, on the other hand, does not show any significant difference being already quite rich.

A significant increase on diversification strategies is also reported both in terms of income sources as well as in terms of crops produced, this is true for the whole sample as well as across the states with the exception of Oaxaca.

In terms of expected impact on social capital, this study cannot find any significant increase except for greater presence of women's groups and of the existence of at least one association in participant villages, which however is not reflected in a leadership role of women nor of youth in business or other economic activities or social groups. Similarly, non-significant impacts are reported on the increase of *avecindados* participating to economic activities and to project financed activities. However given their very low presence of youth in key indicators and, therefore of very low number of observations, it is not possible to draw any final conclusion.

A better access to market is also reported when proxied by a better transportation system and by an increase in accessing agricultural input and in the increase of sales to direct consumers without the use of intermediaries. However results in this regard are not very strong.

Overall, the project shows interesting and good results, which are stronger for more focussed and more tailored-to-development-needs and characteristics of the states participating to the project, whereas they are not robust, scattered and not significant where the project had a more diversified and less focussed type of intervention.

Results reported in the present Impact Assessment show once again that more focussed and interlinked type of intervention which respond to a strong logic and which addresses the development needs of the area of intervention are usually more successful in achieving desired impacts and in determining a transformation of the local economy.

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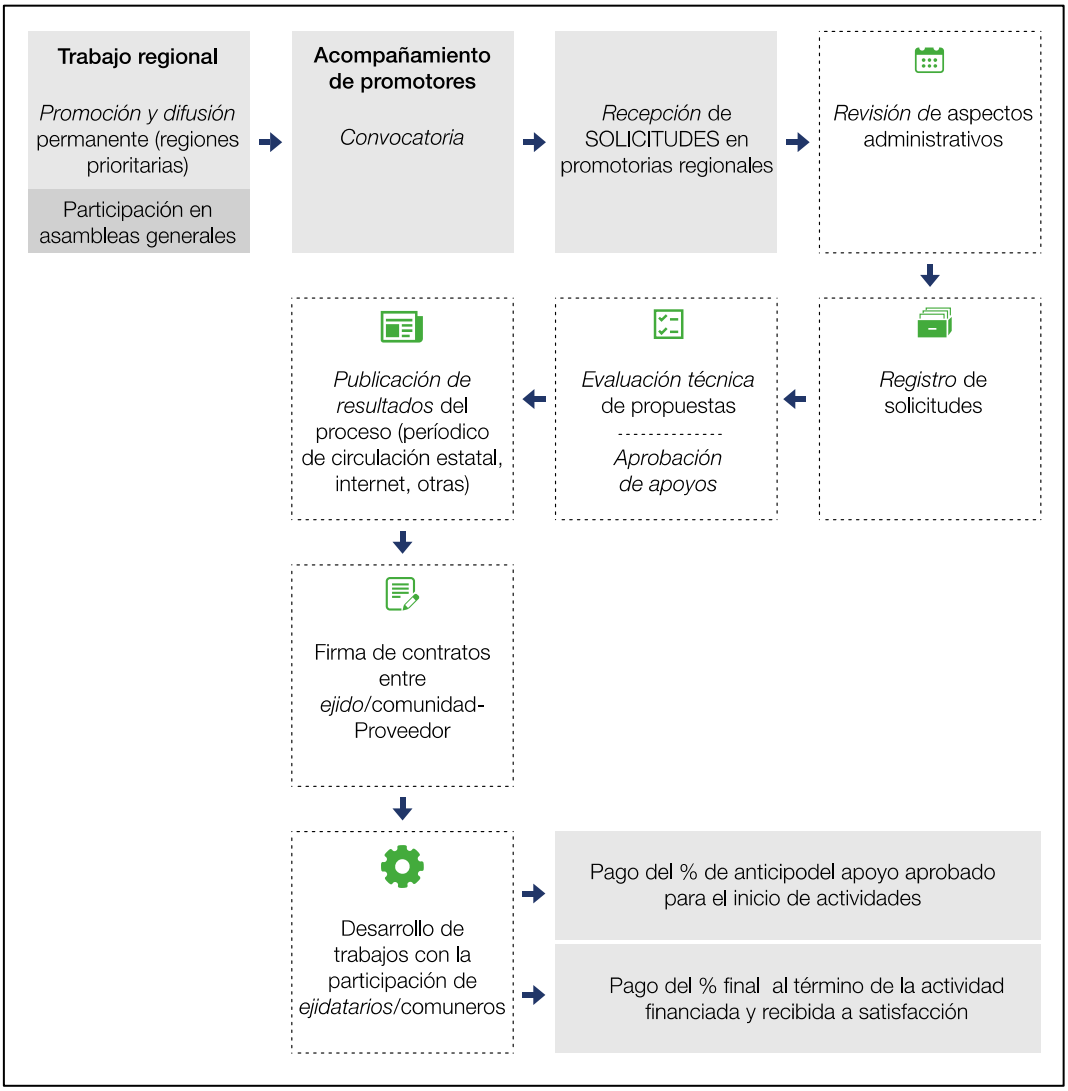
Appendix

Table A1. List of DECOFOS eligible municipalities by State

Campeche	Chiapas	Oaxaca
1. Calakmul	1. Altamirano	1. Asunción Cacalotepec
2. Calkiní	2. Amantenango Del Valle	2. Mixistlán de la Reforma
3. Campeche	3. Ángel Albino Corzo	3. San Andrés Solaga
4. Carmen	4. Benemérito de las Américas	4. San Andrés Yaá
5. Candelaria	5. Bochil	5. San Baltazar Yatzachi el Bajo
6. Champotón	6. Coapilla	6. San Bartolomé Zoogocho
7. Escárcega	7. El Porvenir	7. San Cristóbal Lachirioag
8. Hecelchakán	8. Ixtapa	8. San Francisco Cajonos
9. Hopelchén	9. Jitotol	9. San Ildefonso Villa Alta
10. Palizada	10. La Concordia	10. San Juan Comaltepec
11. Tenabo	11. Las Margaritas	11. San Juan Cotzocón
	12. Maravilla Tenejapa	12. San Juan Juquila Vijanos
	13. Marqués de Comilla	13. San Juan Lalana
	14. Montecristo De Guerrero	14. San Juan Mazatlán
	15. Motozintla	15. San Juan Petlapa
	16. Ocosingo	16. San Juan Tabaá
	17. Ocotepec	17. San Juan Yaeé
	18. Siltepec	18. San Juan Yatzona
	19. Soyalo	19. San Lucas Camotlán
	20. Teopisca	20. San Mateo Cajonos
	21. Villacorzo	21. San Melchor Betaza
		22. San Miguel Quetzaltepec
		23. San Pablo Yaganiza
		24. San Pedro Cajonos
		25. San Pedro Ocotepec
		26. San Pedro y San Pablo Ayutla
		27. Santa María Alotepec
		28. Santa María Temaxcalapa
		29. Santa María Tepantlali
		30. Santa María Tlahuitoltepec
		31. Santa María Yalina
		32. Santiago Atitlán
		33. Santiago Camotlán
		34. Santiago Choápam
		35. Santiago Ixcuintepec
		36. Santiago Lalopa
		37. Santiago Yaveo
		38. Santiago Zacatepec
		39. Santiago Zoochila
		40. Santo Domingo Roayaga
		41. Santo Domingo Tepuxtepec
		42. Santo Domingo Xagacía
		43. Tamazulapam del Espíritu Santo
		44. Tanetze de Zaragoza
		45. Totontepec Villa de Morelos
		46. Villa Hidalgo Yalalag
		47. Villa Talea de Castro

Figure A1. Diagram of DECOFOS implementation



Source: DECOFOS Workshop Report, June 2008.

Table A2. Type and amount of supports requested and granted

Components and intervention	Amount granted	Nb. of supports granted
Componente I. Fortalecimiento de las capacidades para la organización, planeación, gestión local y cambio climático	22,153,071	452
Capacitación para el monitoreo comunitario en adaptación y mitigación al cambio climático (CMCA)	667,118	16
Evaluaciones rurales participativas (ERP)	1,096,200	29
Estudios Técnicos EEAC	450,000	5
Formulación del plan local de desarrollo (FPLD)	1,495,000	33
Intercambios de experiencia (IE)	76,500	1
Promotor forestal comunitario (PFC)	1,074,600	16
Seminarios de comunidad a comunidad (SCC)	5,091,067	69
Talleres y cursos de capacitación técnica (Talleres)	3,030,620	85
Talleres de sensibilización para la mitigación y adaptación al cambio climático (Talleres_C1)	6,692,045	140
Constitución y registro legal de microempresas rurales (CRLM)	2,479,921	58
Componente II. Proyectos y negocios forestales	**111,679,330**	**600**
Ejecución de Proyectos de Microempresas Rurales (EPMER)	60,161,753	125
Formulación proyectos de inversión (FPI)	4,774,500	80
FPN Formulación del plan de negocios (FPN)	1,290,000	19
Modulos Agroforestales (MA)	17,765,142	174
Proyectos de transferencia de tecnología (PTT)	20,454,831	144
Viveros comunitarios (VC)	7,233,104	58
Total general	**133,832,401**	**1,052**

Figure A2. Common support between treatment and control groups

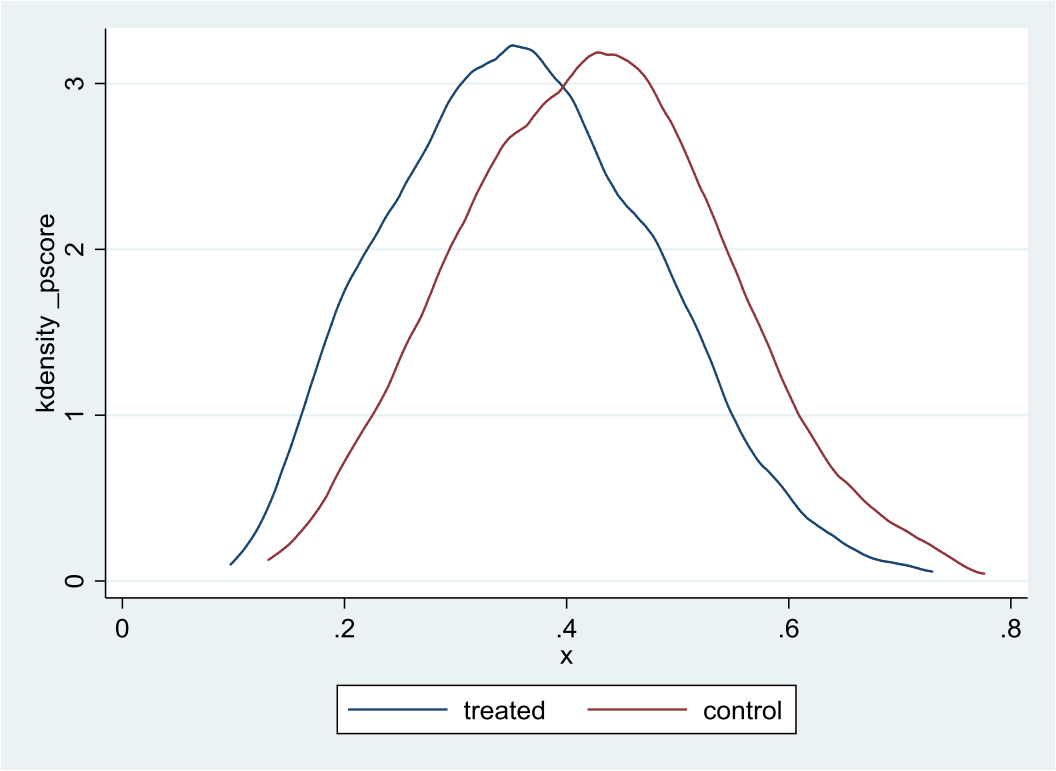


Figure A3. Bias reduction before and after matching

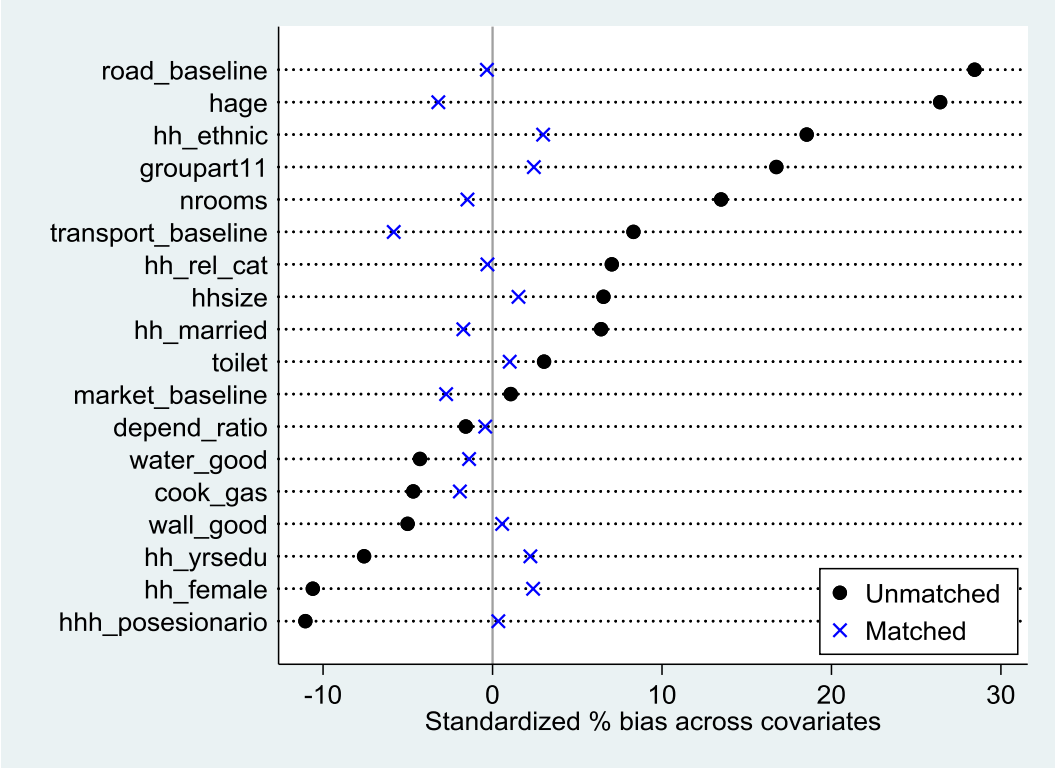


Table A3: Indicators used in the analysis

Environmental benefits and resilience

Indicators related to environmental benefits consist of:

- Normalised Diversity Vegetation Index: remote sensing indicator that assesses the live green vegetation of areas under analysis;
- Precipitation coefficient: long term average and last year average amount of precipitation in mm;
- Use of common land based on legal permits: which is used as a proxy to indicate sustainable use of resources;

- An index representing a household's ability to recover from shocks – both climatic and economic – weighted by the perceived severity and frequency of shocks experienced since project baseline.
- A self-reported assessment of having been damaged by climate related shocks (which is run in parallel by objective measurement of drought or other weather anomalies or shocks).

Economic mobility: income, wealth and poverty indicators

Indicators measuring economic mobility consist of:

- Total net household income. This includes total value of crop harvest, sales of livestock and value of livestock sub products produced, income from agro-forestry activities, family enterprises, wage employment, and other sources (such as pensions or remittances), net of all costs.
- Asset indices, constructed using principal component analysis for a count of various productive goods and multiple correspondence analysis for binary indicators of durable goods. An overall index is then constructed using polychoric factor analysis.
- A binary indicator, signalling whether a household is below an asset-based poverty line set at the 40^{th} percentile and 60^{th} percentile of the control group's asset index.

Food diversity, food security and resilience indicators

To measure food security and diversity, we make use of four types of indicators:

- A count of the number of meals the household consumes per day on average
- The Food Insecurity Experience Scale (FIES) for measuring severity of food insecurity based on household adult members' responses on food-related behaviours and experiences associated with increasing difficulties in accessing food (FAO, 2017).
- The Household Dietary Diversity Score (HDDS) of the week prior computed based on twelve food groups (FAO, 2010).

Income composition indicators

In order to measure productivity and market capacity, we construct various indicators which are measured at a sub-group level by project type (either a livestock or agriculture intervention):

Agriculture project indicators:

- Income from sustainable production of timber and non-timber forest products.
- Crop net income constructed using the RIGA methodology; crop revenues including sales of crops and crop sub-products; and gross margins of revenues net of production costs.
- Crop diversification calculated using the Gini-Simpson Index.
- Income from non-farm activities related to processing and commercialization of forest products.
- Number of household enterprises and business involved in sustainable production of timber and non-timber forest products and eco-tourism.
- Number of people employed in agri-business activities from the households and from the communities, disaggregated by gender, age and status (*i.e., avecindados vs ejidatarios*)

Social capital, gender and financial management capacity indicators

Finally, a number of indicators related to social capital and gender were included in accordance with the project's theory of change:

Group participation:

- Binary indicators of group participation and leadership, disaggregated by gender, age and status.
- The total number of groups in which any household members participate and frequency of meetings.

Collective action:

- A binary indicator for whether the household has collaborated with other community members to meet needs expressed by the community.

Table A4: Results on indicators on crop yield and input use

	ATET	N	Whole sample mean	Treatment mean	Control mean
(log) Yield for yellow maize (kg/ha)	0.389*	392	6.20	6.31	6.11
(log) Expenditure for inputs (MXN)	0.344**	1 634	1.91	2.11	1.74
(log) Kg/ha of inorganic fertilizer	-0.115	1 253	4.29	4.16	4.40
(log) Kg/ha of organic fertilizer	0.199**	1 544	0.44	0.58	0.32

Table A5. Descriptive statistics on the main impact indicators for beneficiary and control groups

Variable	Beneficiaries			Control			p-value	SMD
	N	Mean	SD	N	Mean	SD		
Ability to recover from shocks	522	2.37	1.01	735	2.19	0.98	0.001	0.183
HH affected by climate shocks since 2011 (%)	855	52.87	49.95	1 102	56.99	49.53	0.069	.
Household is required to have permission to exploit common land	841	15.10	35.83	1 100	7.64	26.57	0.000	.
Total net household income (USD)	847	1 263	3 655	1 095	1 074	2 830	0.201	0.058
Durable assets index	855	0.46	0.10	1 102	0.45	0.10	0.038	0.094
Productive assets index	855	0.38	1.24	1 102	0.22	0.77	0.000	0.163
Total asset index	855	0.22	0.33	1 102	0.18	0.21	0.000	0.169
Households below asset-based poverty line, 40th percentile (%)	855	34.27	47.49	1 102	39.56	48.92	0.016	.
Households below asset-based poverty line, 60th percentile (%)	855	51.81	50.00	1 102	59.98	49.02	0.000	.
Net income from crops (USD)	763	731.67	3 003	872	723.00	2 741	0.951	0.003
Income from sales of tree resources (USD)	770	4.88	80.03	877	1.79	31.07	0.291	0.051
Income from sales of natural resources from common land (USD)	841	23.39	209.28	1 100	2.62	29.07	0.001	0.139
Share of gross crop income from sales	607	31.47	39.56	722	28.56	39.79	0.358	.
Gini-Simpson index of crop diversification	784	0.29	0.32	879	0.25	0.32	0.005	0.138
Nr. of parcels operated by the household	821	1.89	1.41	963	1.63	1.14	0.000	0.201
Households exploiting natural resources from common land (%)	841	56.36	49.62	1 100	49.45	50.02	0.003	.
Part. in farmers groups (1=yes)	855	4.80	21.38	1 102	2.90	16.80	0.029	.
Number of meals per day consumed by the household	844	2.70	0.46	1 089	2.63	0.50	0.001	0.152
Food Insecurity Experience Scale score for Adults	855	1.58	1.71	1 102	1.78	1.69	0.009	-0.119
Food Insecurity Experience Scale score for Children	855	0.50	1.27	1 102	0.60	1.36	0.099	-0.075
Household Dietary Diversity Score (HDDS), weekly	855	9.69	2.55	1 102	9.74	2.51	0.678	-0.019
Part. in women groups since 2011 (%)	855	2.34	15.12	1 102	1.63	12.68	0.262	.
Households with business activities selling products to final consumers (%)	855	7.25	25.95	1 102	5.81	23.40	0.197	.
Households with business activities selling products to traders (%)	855	2.57	15.84	1 102	2.81	16.54	0.746	.
Community has new transport system since baseline	855	14.04	34.76	1 082	10.44	30.60	0.016	.

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