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IMPACT ASSESSMENT REPORT

Tajikistan

Livestock and Pasture Development Project **(LPDP)**

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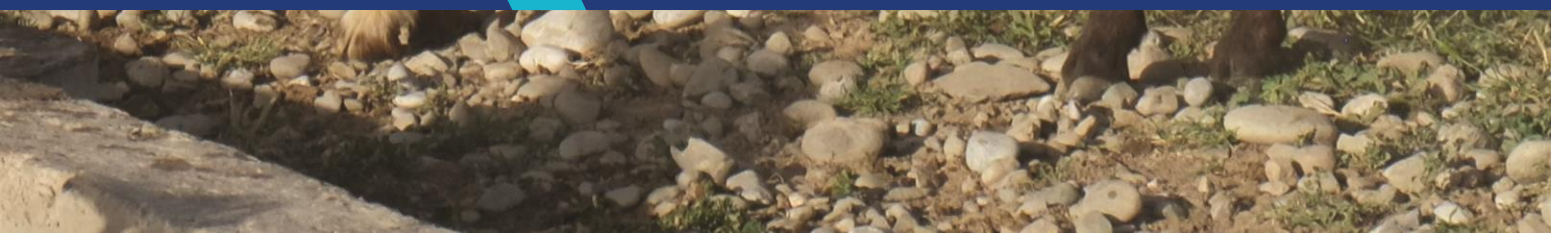
IFAD
Investing in rural people



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Romina Cavatassi, Paola Mallia, 2018, Impact assessment report: Livestock and Pasture Development Project (LPDP), Tajikistan. IFAD, Rome, Italy.

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Acknowledgements

The authors would like to thank Dr Sadi Karimozoda, Director of the State Enterprise Project Management Unit of the "Livestock and Pasture Development", Mr Turakul Murodov Project Coordinator of the LPDP under the SE project Management Unit, Mrs Irina Barotova, M&E officer of the LPDP and many other representatives and collaborators of the PMU for the LPDP projects for their useful guidance and input during the design phase of the Impact Assessment and sampling selection. The authors are also deeply grateful to Mikael Kauttu for input, information, guidance and support throughout the impact assessment phases; to Paul Winters, Associate Vice President of the Strategy and Knowledge Department of IFAD for his guidance and insightful suggestions throughout IA implementation and for earlier versions of this document. Special thanks go also to other IFAD colleagues that helped throughout the IA of the LPDP for their useful insights and input: Sylvia Schollbush and Jepsen Frits. A special thank goes to our colleagues Adriana Paolantonio and Federica Alfani for their help with data analysis and insightful discussion.

Table of contents

Executive summary 3

1. Introduction 6

2. Theory of change and main research questions 8

2.1 LPDP theory of change 8

2.2 Project coverage and targeting 12

2.3 Research questions 13

3. Impact assessment design: Data and methodology 15

3.1 Data 15

3.2 Questionnaire and impact indicators 20

3.3 Impact estimation 22

4. Profile of the project area and sample 23

5. Results 25

5.1 Overall impacts of 25

5.2 Heterogeneous impacts of 28

6. Conclusion 35

References 37

Appendix: 39

Executive summary

The Republic of Tajikistan is a land locked country, where most of the territory (93%) is occupied by mountains. Poverty is quite widespread with about half of the country's population living below the poverty line. The poorest people in the country reside in the Khatlon region, where 78 per cent of the population lives under the national poverty line and where land is degraded, the availability of inputs and credit is limited, irrigation facilities are lacking, and access to improved technologies and markets is poor (World Bank, 2015).

About 50 per cent of the population depends on agriculture for livelihood, and most farmers lack access to adequate inputs, resources, technology and markets. Livestock is a key part of the agricultural sector and it is of critical importance in the livelihood strategy of poor rural households in Tajikistan.

The pasture management system in Tajikistan remains largely unchanged since Soviet times with the exception that the lowest rung in the management system (corporate farms) no longer has adequate resources for pasture upkeep nor an adequate management system. The inadequacy of such a centralized management system is reflected in the overexploitation of pasture which has led to a vicious cycle of ever-lower animal yields and rural income, which is triggered by the legitimate will of farmers to increase their livestock production by adding animal units. This, in turn, has created a greater demand for feed, leading to a decrease in the feed per animal ratio, to a deterioration of the grazing land and to a further fall in animal weight. As a result, the rise in livestock inventories coupled with the fall in feed supplies has meant the dramatic fall of livestock productivity, low milk and meat yields and land degradation in the country, further worsening poverty among households.

To address and overcome these problems, the Government of Tajikistan launched the Livestock and Pasture Development Project (LPDP) in August 2011, a project financed jointly by IFAD and the Government of the Republic of Tajikistan. The project had the goal of reducing poverty in the Khatlon region, increasing the nutritional status and incomes of rural poor households by boosting livestock productivity through the improvement of the productive capacity of pastures.

The project, which was implemented in the poorest region of Tajikistan, the Khatlon region, comprised three main components which aimed at: developing an institutional capacity at the village level creating managerial structure and social cohesion in managing pastureland, through the establishment of Pasture User Unions (PUUs, henceforth); at improving livestock husbandry practices and increasing fodder production and livestock production and productivity. Finally, a third component aimed at empowering women by providing trainings and livestock packages to vulnerable female-headed households.

This impact assessment investigates whether the LPDP project, contributes to a positive economic mobility of project beneficiaries through increase in livestock income and livestock capital and other measure of economic mobility measured through key outcome indicators of nutrition, resilience and access to market, infrastructure and services linked to livestock husbandry. We also check whether there have been positive impacts on social cohesion and legal land rights both overall as well as looking at women's role in decision making and income generating activities linked to livestock. Last but not least we look at potential environmental benefits linked to better pasture management.

In order to answer these questions, this ex-post evaluation makes use of a non-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 2,400 household surveys from direct beneficiaries of the project, and people from control villages which represent 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 project selected eligible jamoats in the region looking at the highest poverty rate, village population and pasture carrying capacity, whereby a minimum size of pastureland was requested to ensure livestock development. The selection of beneficiaries included a two steps approach. In the first step eligible jamoats were identified based on criteria indicated above, eligible villages where the same selection criteria where applied, have been selected within eligible jamoats. Given the targeted number of beneficiaries, the results of the selection have been that all jamoats and villages that complied with the targeting criteria ended up being part of the LPDP project. Similarly, all households in participant villages were beneficiaries of the project. Whereas this may have presented a difficulty in selecting the comparison group, the starting of the LPDP-II in other districts of the same region, which followed very similar targeting criteria, allowed an easy selection of the control group for this impact assessment. Indeed the control group has been sourced among beneficiaries of the LPDP-II, whereby the same selection criteria at jamoat and villages level has been applied, followed by a propensity score matching to ensure the highest possible comparability between treated and control group.

Results of the analysis conducted show that the impacts of the project on the beneficiary group are positive and significant in increasing income as well as on productive assets. This is particularly true when it refers to livestock income or to livestock related assets, but although with a smaller magnitude, positive impacts also apply to crop income. Positive results are clearly reflected also on the larger livestock herd as well as on the weight of the animals that are part of the herd. These positive results seem to be determined by better access to and reduced costs of water as well as of tractor services provided by the PUU, but it is also due to the adoption of improved or controlled breeding and mating techniques. Nonetheless, these positive results are not reflected in the increase of milk production. This is possibly due to the fact that the focus of the livestock production increase is on meat rather than on milk and dairy as also expressed by lower animal weight at young age as opposed to adult age. Another line of reasoning would suggests that compliance with pasture rotational plans without observing a parallel increase in the amount of fodder or other type of animal feed, which would be needed to increase feed resources for an increased livestock herd, leads to lower milk harvested.

Beneficiaries are also more resilient across the sample. Those affected by the most frequently occurring shocks show a good level or resilience measured by income and assets indicators as compared to control households affected by the same type of shocks. In terms of social capital there is a stronger participation of households members in village level associations; looking at results from a gender perspective, we find a larger participation of women in decision making; in addition, beneficiary women headed households have a larger income than the control women headed households.

Overall the project shows positive and significant impacts on the main indicators that measure projects' outcomes, namely livestock income, size and weight which is supported by the establishment of the PUU and by developing their capacity towards sustainable livestock management. However, the increased livestock herd and size may raise some issues of concerns with regard to the carrying capacity and to the environmental benefits of the project which should be obtained through establishment of rotational plans on pastureland to which the project report compliance. Given the positive synergies expected by the project it would be advisable to also try to measure the actual mitigation potential coming from livestock feed and management.

Overall the results suggest that there has been a good economic impact and that environmental aspects should be also on the positive track thanks to the establishment and compliance with rotational plan, although fodder and other feeding sources are not higher in the beneficiary group

which suggest a more location specific type of monitoring which is indeed being implemented for the LPDP-II.

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. It also suggests, however, that natural resources endowment and carrying capacity should be carefully accounted for and monitored.

1. Introduction

The Republic of Tajikistan is a land locked country, where most of the territory (93%) is occupied by mountains. Poverty is quite widespread with about half of the country's population living below the poverty line. The poorest people in the country reside in the Khatlon region, where 78 per cent of the population lives under the national poverty line and where land is degraded, the availability of inputs and credit is limited, irrigation facilities are lacking, and access to improved technologies and markets is poor (World Bank, 2015).

About 50 per cent of the population depends on agriculture for livelihood, and most farmers lack access to adequate inputs, resources, technology and markets. Livestock is a key part of the agricultural sector and it is of critical importance in the livelihood strategy of poor rural households in Tajikistan. Prior to the fall of the socialist system, livestock production was based on an elaborate system aiming at securing animal feed in the winter using (i) intensively–cultivated crops in large-scale state and collective farms, (ii) sizeable imports of concentrates and (iii) a centralized structure of pasture management and utilization. After 1991, the deterioration of these three pillars transformed the livestock husbandry system in Tajikistan from one based on intensive livestock farming to one based on extensive livestock husbandry. Today, the pasture management system in Tajikistan remains largely unchanged since Soviet times with the exception that the lowest rung in the management system (corporate farms) no longer has adequate resources for pasture upkeep nor an adequate management system. As a matter of fact, there exist a mere contradiction between the common use of pastureland without proper management and the private household livestock farms whereby livestock husbandry relies primarily on grazing supplemented by limited cultivated feed crops and minimal concentrates. The inadequacy of a such centralized management system is reflected in the overexploitation of pasture, free-riding behaviours and conflicts between villages over the use of the surrounding land. This extensive livestock production system has led to a vicious cycle of ever-lower animal yields and rural income which is triggered by the legitimate will of farmers to increase their livestock production by adding animals units which in turn has created a greater demand for limited feed, leading to a decrease in the feed per animal ratio, to a deteriorarion of the grazing land and to a further fall in animal weight. As a result, the rise in livestock inventories coupled with the fall in feed supplies has meant the dramatic fall of livestock productivity, low milk and meat yields and land degradation in the country further worsening poverty among households.

In order to enhance livestock productivity in a sustainable manner, in August 2011, implementation began of the Livestock and Pasture Development Project (LPDP), an initiative financed jointly between IFAD and the Government of the Republic of Tajikistan. The project had the goal of reducing poverty in the Khatlon region, increasing the nutritional status and incomes of rural poor households by improving the productive capacity of pastures and consequently increase livestock productivity. The projects' goals and development objectives are aligned with those of the National Development Strategy (NDS) 2006-2015 and of the Poverty Reduction Strategy 2010-2012 (PRS III). The project lasted six years in total and was completed in 2017.

The project entailed three main components: a) the first component focused on institutional development through the establishment of Pasture User Unions (PUUs, henceforth) in order to guarantee land rights to the members and to facilitate common pasture management and rehabilitation; b) the second component, namely Livestock and Pasture Development, comprised a number of activities aiming at improving livestock husbandry practices and increasing fodder production and ultimately livestock production; c) finally, the third component aimed at empowering women by providing trainings and livestock packages specifically to vulnerable female-headed households.

This impact assessment investigates whether the LPDP project 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 non-experimental approach that combines statistical methods and qualitative analysis to identify a valid counterfactual.

We rely on one round of data collected between February and May 2018. Data are comprised of 2,400 household surveys from beneficiaries of 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, migration 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. Section 4 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 5.

2. Theory of change and main research questions

2.1 LPDP theory of change

The reasons for households to raise livestock are several and tend to vary in accordance to their level of income, context and endowment. From cash income to food, from manure to draft power in agriculture, livestock provides a number of benefits to millions of agrarian households in developing countries, contributing to households livelihoods through direct and indirect pathways. In particular, livestock can contribute to wealth providing cash and in-kind income through the sale of animals and/or the sale and consumption of animal derived products such as milk, meat, eggs and others (Bebe et al. 2003). Moreover, livestock is a safety net in the form of liquid assets, thus it is usually considered as a source of savings and insurance given the fact that the sale of animals provides immediate cash flow to deal with unexpected economic shocks (Moll, 2005, Randolph et al., 2007). In addition to that, the ownership of herds can ease the access to formal and informal credit thanks to the possibility of being used as collateral (Upton, 2004). When analysing the linkages to nutrition, livestock shows even more interesting and beneficial aspects, though they also raise controversies linked to meat consumption and livestock's contribution to GhG emissions. From a nutritional point of view, animal-source foods are nutritionally dense sources of energy, protein and various essential micronutrients. They match particularly well with the nutrients needed by people to support growth, regular development, physiological functioning, and overall good health. Even in small amounts, foods of animal origin can play an important role in improving the nutritional status of low income households by addressing micro- and macronutrient deficiencies, particularly those of children and pregnant and lactating women (Neumann et al., 2002). Available evidence indicates that in the poorest countries, where micronutrient deficiencies are most common, a moderate intake of food of animal origin will improve the nutritional adequacy of diets and improve health outcomes (Smith et al. 2013).

Inadequate quantity and quality of animal water and feed resources are major factors constraining the productivity of livestock farming in developing countries. The shortage of water and feed for animal has detrimental consequences for household's food supply and income particularly for poor people who rely on agriculture as a source of food and spend considerable time in collecting these resources (Mekonnen et al. 2015; Yilma et al. 2011). The environmental depletion of resources which poor rural household are forced into, further impoverish them by dragging them into a downward spiral (Ostrom et al. 1991). This is especially true in countries like Tajikistan, where the morphological characteristics of the territory are less favourable for agricultural production, unemployment in the off-farm sector is widespread and smallholders have few opportunities to diversify into non-livestock income-enhancing activities, hence, increasing livestock productivity is a promising channel to alleviate poverty.

The decline of the Soviet system of animal feeding has led to a dramatic fall of intensively-cultivated feed crops yields and area, which has caused an initial fall in livestock inventories. The rapid individualization of livestock herds and the end of hostilities in Tajikistan ushered in a new era of rapid growth in livestock inventories based on household farms. The rapid expansion of livestock stocks despite the fall in feed availability has kept feed availability per animal extremely low, leading to an overexploitation of the common pasture land. Thus, a major constraint to improvement of livestock productivity is the lack of a proper system of pasture management with the necessary resources to perform pasture management and rehabilitation (Sedik, 2009).

Sustainable livestock management with accurate pasture use and animal feeding are crucial to avoid a downward spiral into natural resource depletion which can be triggered by overgrazing and land

erosion and which, coupled with methane emissions, lead the livestock sector to emerge as one of the top most significant contributor to environmental concerns from local to global scale (Henning et al, 2006). The livestock sector is indeed the largest anthropogenic user of land worldwide, the land area occupied by grazing is equivalent to 26 percent of the usable land surface, moreover feedcrop production amounts to 33 percent of total land area. Likewise livestock production is a key factor in deforestation and the pressure on land and overgrazing leads to local and global environmental costs of land erosion linked to GhG emissions. Yet, at the same time, livestock can also tremendously contribute to the GhG emission reduction if sustainably managed. As a matter of fact, the livestock sector contributes to 18 percent of GhG emission measured in CO2 equivalent which offers large possibilities to mitigate climate change through appropriate management of livestock feed and management, which is one of the purposes of the LPDP approach.

The LPDP project is meant to address the above mentioned development problems through different activities interlinked using synergies rather than generating the trade-offs that may be connected to an unsustainable use of resources. Graph 1 presents the list of activities implemented through the projects and the causal mechanisms that are expected to lead to the desired impacts (i.e. Theory of change). The theory of change is the result of the work of the RIA team with the crucial contributions gathered from the discussions with the Project Management Unit (henceforth, PMU) and the direct beneficiaries of the projects.

The set of activities related to the first component entails the establishment of a decentralized management unit for pasture, namely the Pasture User Unions (PUUs, henceforth). PUUs are created at the village level with the intent to acquire the formal legal rights for pasture use, which are transferred directly to the members. Once the legal setting of the union has been set up, the board of the members pools together the resources needed for the maintenance of the pasture land, creates a rotational plan and the union becomes the channel through which the need-specific project's activities are implemented. The legal framework created by the PUUs should decrease the disputes and conflict over land use both between members of the community and nearby villages. Moreover, by setting individual responsibilities on each member, the internal organization of the PUUs is expected to decrease free-riding behaviours which usually lead to overexploitation of pastures and consequent land degradation. In addition to this, the implementation of a rotational plan for pasture is expected to increase land available for grazing in a sustainable manner thereby contributing to sequestration of CO2 and therefore to mitigation of climate change (USAID, 2015). At the Jamoat[1] level, this component should translate into greater community cohesion and improved quality of pasture land.

Livestock productivity heavily depends on the quantity and quality of feed and water. The lack of sufficient feed and water availability constraints significantly animal productivity (Bezabih & Berhane, 2014). Providing improved seeds and fertilizers for fodder production and building water points, animal sheds and veterinary services should lead to an increase in livestock production and productivity thanks to higher water availability and to better, more nutritious and sufficient feed. Moreover feed needs should be reduced in the harshest seasons thanks to shelters which allows for less calories dispersion from livestock in the coldest season when pastures cannot be reached. These actions should lead to comply with the pasture carrying capacity and therefore to a reduction of land erosion from overgrazing and should lead to less emission from pastureland and from methane. In overgrazed pastures, reducing grazing pressure can lead to soil carbon sequestration. Grass productivity and soil C sequestration can also be improved by increasing grazing pressure on pastures where it is too low (Henderson et al., forthcoming). Therefore, improved grazing management by adjusting grazing pressure can contribute to reduce emission intensities by improving grass productivity and soil carbon sequestration. Optimizing grazing intensity can be

[1] The administration system in Tajikistan is hierarchically organized as follows: (i) Oblast (region) which are divided into (ii) Hukumat (district) which in turn are subdivided into (iii) Jamoat (village-level self-governing units) and then (iv) villages.

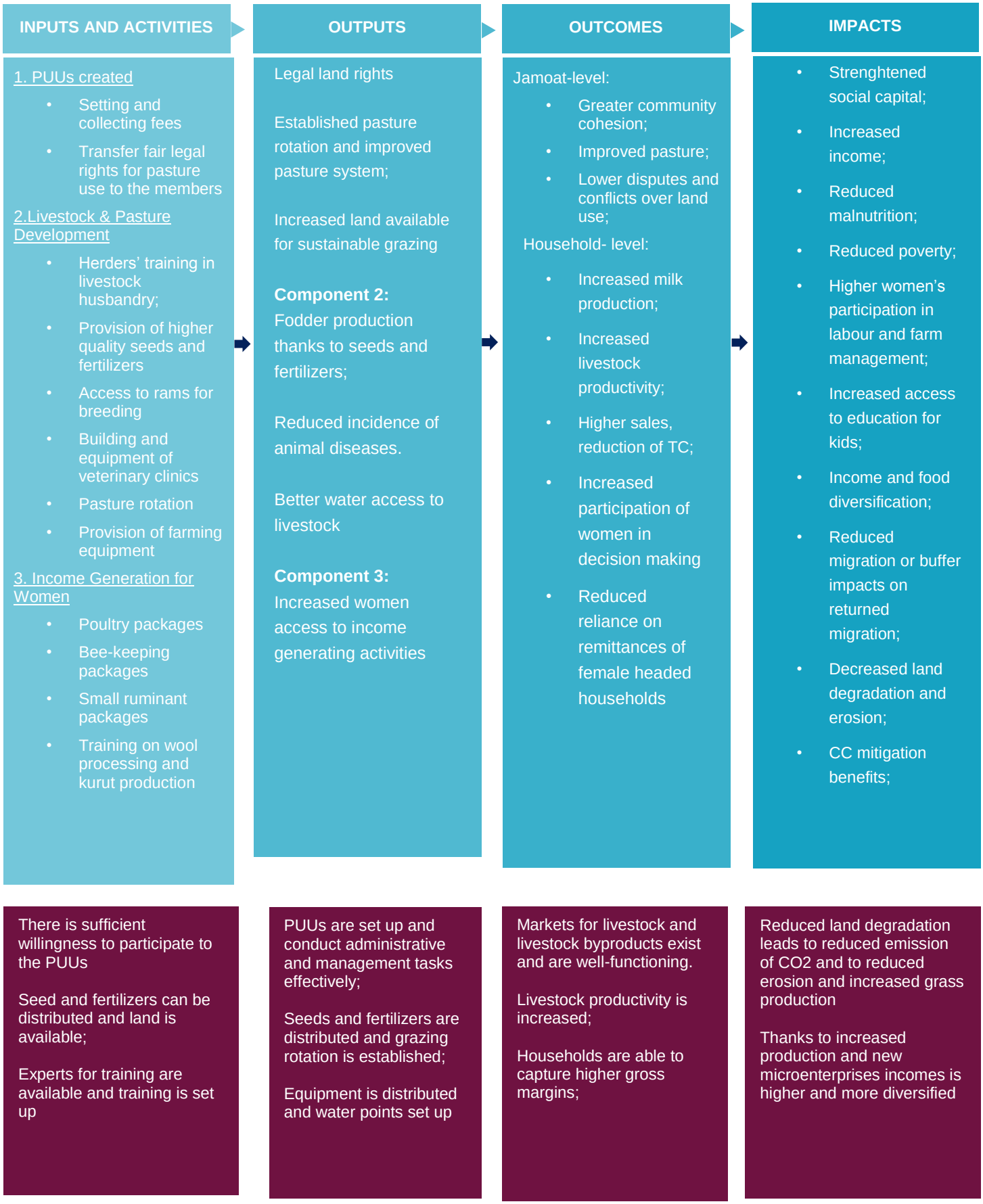
achieved by avoiding overgrazing, this can be implemented by increasing mobility, and by making adjustments to grazing and pasture resting period (Mottet et al., 2016; Henderson et al., forthcoming), which is one of the purpose of the LPDP project further strengthened in its second phase. Likewise, appropriate breeding practices and reproductive management can lead to reduced emissions, also one of the purposes of the project more explicitly identified and highlighted in its second phase LPDP-II . In other words, if appropriately managed the approach taken in the LPDP could be twofold: increase livestock productivity and production through better nutrition thanks to distribution of fodder seeds and through appropriate breeding and reproductive management avoiding overgrazing so to ensure rehabilitation of degraded land and mitigation objectives.

As part of the project, the PMU also supported groups of small-scale Gissar sheep breeders providing each group with Gissar rams to improve the quality of local sheep breeds. Livestock ownership is expected to increase households welfare through own-consumption or income generation (Jin et al. 2014). Building veterinary clinics or adequately equipping the already existing ones, should lead to an easier access to veterinary services thus decreasing the incidence of animal diseases. The expected deriving outcome from these activities entail benefits at the household level such as increased livestock productivity, income and food diversification and consumption (Hadush, 2017).

The third set of project activities is expected to improve women livelihood conditions by widening the spectrum of income generating activities available. In particular, it provides small ruminants, poultry and bee-keeping packages to female household-heads, which are expected to increase their income and, thus increase their bargaining power in the household decision-making process.

These three components of the projects are inter-linked and are expected to act together in increasing income, reducing malnutrition (especially among children), reducing poverty and achieving food security while contributing to climate change mitigation. The efficiently planned use of pastures should rehabilitate fertility of degraded land due to overgrazing thereby contributing to adaptation to climate change (through sheds, water points and distribution of seeds) but also contribute to climate change mitigation benefits produced by rehabilitated pastureland. Moreover, given the gender dimension component, it is expected that the LPDP will lead to greater women empowerment smoothing the negative impacts of high rates of male migration.

Figure 1: The Theory of change



2.2 Project coverage and targeting

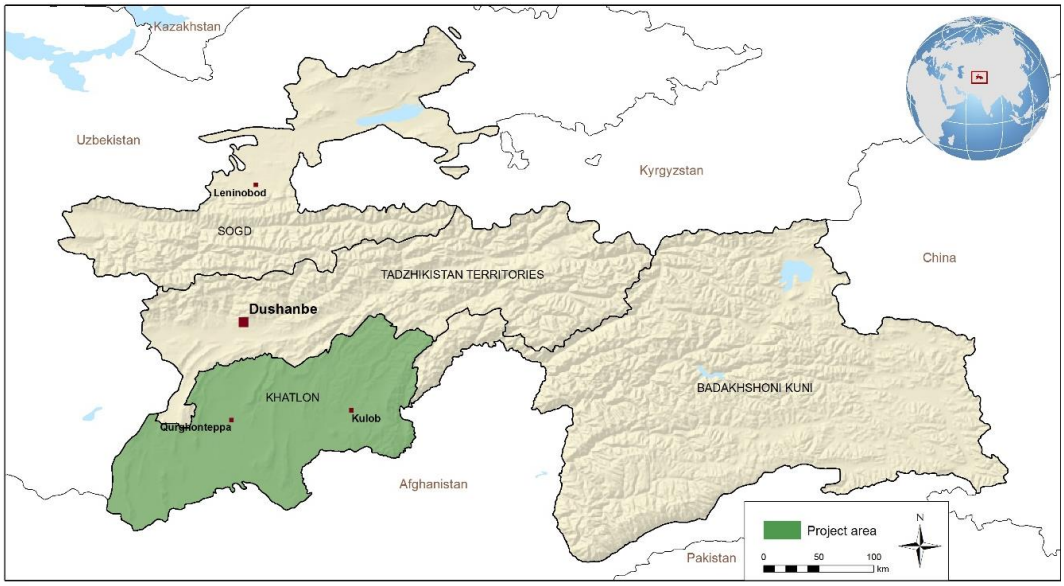
The LPDP project has been implemented in selected districts of the Khatlon region which is the poorest region of the country, with poor and very poor households comprising 78% of the total population [2] in the region. The districts of Muninabad, Khovaling, Baljuvon, Sharabad and Temurmalik were selected considering the level of poverty. The original selection of the LPDP design was to also include Farkhor and Vose districts, however, due to the reduced available funding caused by the depreciation of SDR against USD, these two districts were postponed to the second phase (LDPD-II)[3]. Within each district, only jamoats with overall livestock carrying capacity of pasture below 5 where considered as eligible. This measure is calculated using the ratio between the overall pasture area available and the total number of sheep units, where the latter is a standardized measure of the livestock inventories based on their consumption of forage. Inside each targeted jamoat, the selected villages had to have: i) livestock carrying capacity of pastures below 5 and ii) a population of more than 50 households in the first three districts and more than 20 households in the remaining two districts. Also important to note is that once a village has been selected to participate to the projects, there is perfect compliance at the village level, that is: the totality of the households residing in a given village are also part of the PUU and participate to the project.

Part of the challenges in conducting a rigorous IA relate to the proper identification of spillover effects and unintended impacts. The importance of taking into account spillover effects lies in the fact that it may imply a double underestimation or overestimation of project's impacts. In our particular case, since the veterinary clinics built and equipped by the project are freely accessible, we may suspect that not only households from eligible villages but also those from control villages may benefit from them. If this is the case, by simply comparing eligible and ineligible households, we would be (i) underestimating the effect of the provision of veterinary services on the treatment group and (ii) ignoring the positive effect of the treatment on the control group, leading to wrong policy recommendations (Angelucci and Di Maro, 2010). For this reason, it is also important to take into consideration the role played by the possible reduction in the likelihood of contagion when estimating the effect of veterinary clinics services on the incidence of animal diseases and mortality. On the other hand, a properly managed pasture land combined with plots dedicated to fodder production through distribution of forage seeds, may produce not only the private benefits of increased fodder but also the off-site public benefits linked to increased soil fertility and reduced land erosion obtained through rotational plan for pasture use and, last but not least, the global public benefits represented by CO2 sequestration and its consequent contribution to climate change mitigation. Another dimension to be considered is the estimation of unintended changes to the group of beneficiaries due, directly or indirectly, to the projects. During the meetings held in the villages where LPDP was implemented, the beneficiary households reported an increase in school attendance among their children thanks to a greater availability of income, but also to a relaxed time constraint for the children who are not requested to collect water for the animals any longer. Moreover, all the farmers pointed out the possibility to rent at a reasonable cost the farming equipment bought collectively by the PUUs.

[2] Poverty figures obtained using Living Standards Measure Study-2009 data by World Bank.

[3] For more details, please refer to the *LPDP-I Supervision Report 2016*.

Figure 1: LPDP project areas



2.3 Research questions

Given the theory of change described above and the targeting criteria of the project, the following are the key evaluation questions that will help assess the program's impact:

Main Impact indicators:

1. Do beneficiaries show a more positive economic mobility than the control group?
2. Do they have a higher income and is this mainly determined from livestock?
3. Does livestock of beneficiaries show a higher level of production and productivity?
4. Does milk production and productivity increase?
5. Do other livestock related produce increase?
6. Is income more diversified for beneficiaries?
7. Is there an implemented and respected pasture rotation system?
8. Does degraded pasture restore and will it be less prone to land erosion?
9. Does the nutritional status of beneficiaries increase, particularly for children?
10. Is there an increase in income and employment among women as compared to control group?
11. Is there a stronger social cohesion and social participation in beneficiary villages thanks to the PUU?

Mechanisms:

Next we also try to assess under which mechanism the above mentioned indicators have been achieved or not achieved:

12. Has the amount of fodder and feed, different from grazing and pasture, for animals increased?
13. Do new microenterprises lead by women increase in the beneficiary villages?
14. Do beneficiaries adopt specific breeding and reproductive techniques as compared to the control group?
15. Are there more water points and veterinary points in beneficiary villages?
16. Are land rights higher for beneficiaries than for control?

Secondary benefits:

Last but not least we also check if there have been secondary positive benefits for beneficiaries:

17. Does the project lead to higher enrolment in school thanks to more time availability and better income?
18. Are GHG emissions reduced in control villages?

Impact assessment design: Data and methodology

3.1 Data

The design of the LPDP impact assessment used a mixed-method approach whereby both qualitative and quantitative data were used with the purpose of getting a better picture of the project and of its impacts. Qualitative methods which mainly consists of Focus Group Discussion (FGD) and of Key Informant Interviews (KII), are used with a double purpose: on one side they help obtaining a better understanding of the project, of its implementation mechanisms, of the selection criteria, of the benefits achieved and of difficulties encountered. In this regard qualitative methods allow to inform an appropriate sampling strategy and they also allow to design a context specific questionnaire, tailored to the specific mechanisms and approaches of the project.

Qualitative data

The qualitative data collected consisted in a number of Key Informant Interviews (KIIs) and Focus Group discussions with key project stakeholders as well as with participant and non-participant households. The qualitative work had the purpose to improve the sampling framework through the validation of the villages matched using the Propensity Score Matching (PSM). Moreover, it also had the crucial objective of better understanding: (i) the project targeting and the selection process of beneficiary villages; (ii) the characteristics of participant and non-participant villages (to be able to shed some light on possible self-selection mechanisms); (iii) potential spillover and unintended effects. As such, the qualitative analysis conducted allowed to both have a better sense of variables to include in our matching procedure as well as to strengthen and tailor the questionnaire used for data collection to the specific needs of the project. The LPDP impact assessment had entailed six FGDs composed by eight people ensuring gender representativeness and including representatives of the PUU in beneficiary villages and of pastoralists in control villages, and forty KIIs in eight villages including local officers of the LPDP, state delegation, technical advisors, and pastoralists, members of the PUU and members of the project selection committee.

Sampling

The main challenge for identifying impacts is to find a valid control group that has the same characteristics as the treatment group in the absence of the program. When the only difference between the treatment and comparison groups is that the members of the treatment group receive the project's activities, while the members of the comparison group do not, the observed difference in outcomes can be entirely attributed to the program and the causal impact can be identified (Ravallion, 2005).

Once the villages that comply with the eligibility criteria have been identified, finding a valid control group would require to randomly allocate the villages in the treatment and in the control group. The random selection of the treatment group out of the set of villages that satisfy the targeting criteria of the project would ensure that the members of the two selected groups would be asymptotically the same in terms of observed and unobserved characteristics.

The LPDP project has some peculiarities when it comes to the selection of the beneficiaries. On one side, it did not allow to select control villages within the same districts that participated into LPDP as all the villages that complied with the targeting criteria indicated above are project beneficiaries. On the other hand the project offers a unique opportunity in that, in September 2016, a geographic expansion of LPDP to include five additional districts of the Khatlon region has been approved (LPDP-II, henceforth). As such, once confirmed that the targeting criteria of the LPDP-II were the same as those of the original LPDP, we could randomly select a list of villages out of the units

selected as potential beneficiaries for the scaling-up and use those as control villages for LPDP impact assessment.

The first step was therefore to ensure that analogous targeting criteria had been used to select jamoats and villages to participate to LPDP-II. Beneficiary villages were selected from the districts of Vose, Dangara, Kulob, Hamadoni and Farkhor with the following characteristics:

- Jamoats with livestock carrying capacity of pasture below 5;
- Villages with pasture area above 50 hectares;
- Villages with more than 50 but less than 500 households.

The only difference between the two selection criteria (LPDP-I vs. LPDP-II) applied to the project and its scaling up lies in the criteria regarding pasture applied at the village level. In particular, for LPDP-I this measure is the ratio between total pasture area in hectares and the total number of animals in sheep unit[4], while in LPDP-II only the pasture area is taken into consideration, therefore representing a less conservative calculation of the carrying capacity, which we can control for in matching villages in our sampling approach.

In order to accommodate the slightly different targeting criteria of the two projects and after careful consideration of data available, we selected our sample by applying to the list of eligible villages among the LPDPII a statistical procedure, the Propensity Score Matching (PSM) approach, through which we selected non-beneficiary villages with similar characteristics to beneficiary villages in project's targeted districts of the Khatlon region under LPDPI. In applying the methodology we used, in addition to eligibility criteria namely, population, carrying capacity and pasture area, some additional key characteristics such as population, infrastructure at village level and economic setting of the villages.

The idea is to find, from the group of eligible villages for LPDP-II, villages that are "observationally" similar to selected villages not only in terms of pasture area but also in terms of additional characteristics not affected or influenced by the projects. Using PSM, each treated village is matched to a non-selected village on the basis of a single propensity score, reflecting the probability of being selected to be part of the project conditional of their observed characteristics.

One of the main assumption on which the PSM relies is the *common support* or *overlap condition.* This condition ensures that treatment observations have comparison observations "nearby" in the propensity score distribution. Treatment villages, thus, have to be similar to non-treatment villages in terms of observed characteristics unaffected by participation in addition to being eligible using LPDP-I targeting criteria; hence, some non-treatment units will be dropped to ensure comparability.

Once the first step of sampling had been completed, that is villages had been selected for sample using all the steps indicated above, the following step of the sampling implied selection of households within the chosen villages. Given the perfect compliance of the beneficiaries households within villages, and given the impossibility of sourcing the list of households residing in a given village, households to be interviewed within sampled villages were randomly selected through a random walk approach. This process consisted of assigning to each enumerator an address from which he/she had to walk on the right-hand side of the road towards the end of it. From the starting point the enumerators had to pass by 3 housing units and select as a respondent the fourth house encountered, and repeat this process for the rest of the village. Particular care was taken in dealing with multi-unit housing and apartment blocks. In case of a multi-family housing, each apartment was considered as a housing unit. Finally, interviewers conducted a community survey with a selection of community leaders in every survey village and collected livestock measurements with the support of

[4] Sheep unit is a procedure to standardize different livestock types into one unique measure based on their forage consumption. According to this measure, a cattle corresponds to 5 sheep, a horse to six sheep and a donkey to three in terms of consumption.

livestock experts. The initial sample comprised a total of 120 villages (half treatment and half control) with 20 households to be selected in each village in order to reach the total estimated sample size of 2,400 households that was determined through a power calculation as better indicated below.

Treatment			Control		
District	Nb. Of villages	Nb. Of households	District	Nb. Of villages	Nb. Of households
Baljuvon	3	60	**Danghara**	12	240
Khovaling	3	60	**Farkhor**	18	360
Muminobod	17	339	**Hamadoni**	6	120
Shuroobod	14	278	**Kulob**	8	159
Temurmalik	23	458	**Vose**	16	324

In accordance with the Logical Framework of the project, the sample size has been established by performing the statistical power calculation considering the following minimal detectable effects:

Indicator	Increase	Decrease
Income from livestock	20%	
Total income	20%	
Child malnutrition		30%

In order to perform the power calculation on these indicators, we relied on both baseline data of the M&E system of LPDP-I and Living Standard Measurement Study (LSMS) 2009 by the World Bank, given that the whole sampling and calculation refers to when the project started.

Performing the power calculation gives us the following results for sample estimation:

Income from livestock	
Sample size un-corrected	738
Intra-class correlation	0. 09701
Average obs. per cluster	5
Minimum number of clusters	410
Sample size adjusted for cluster design	1025

Total household income	
Sample size needed	373
Intra-class correlation	0.0069768
Average obs. per cluster	9
Minimum number of clusters	88
Sample size adjusted for cluster design	394

Height-for-age

Sample size needed	1096
Intra-class correlation	0. 022747
Average obs. per cluster	5
Minimum number of clusters	479
Sample size adjusted for cluster design	1196

In order to be sure to capture the effect of the project, it is common practice to choose the most conservative number as sample size. Thus, each group will consist of 1200 households interviews.

Quantitative data

Quantitative data were collected at village (PUU) and household level in the Kathlon region in the above indicated districts between February and May 2018 on 2400 households through the use of tablet based questionnaires formulated by IFAD. Data at household level were used to ensure stronger comparability across treatment and control groups running PSM analysis and based on a linear probability model to predict each households' probability to both be selected and to self-select into the project, using variables that act as indicators or proxies of each determining factor identified with qualitative research. **Table 1** presents the list of the variables used for matching with the corresponding selection factor proxied. PSM ensures that any combination of characteristics observed in the treatment group (ideally prior to the intervention) can also be observed among the control group (Bryson et al., 2002).

We choose the nearest neighbour (NN) algorithm to match on the propensity score. Using five nearest neighbours and a caliper of 0.01, the model leaves 13 observations off of common support. Matching results are presented in Figures of the Appendix which demonstrate the success of the sampling strategy to select a control group that can be used as an appropriate counterfactual. In particular, the kernel plot for probability of treatment (**Figure 2** of the Appendix) shows almost perfect overlap between treatment and control therefore confirming the common support assumption. Furthermore, results on the relative bias between unmatched and matched groups (**Figure 3** in Appendix 1) shows that matching considerably reduces the bias across nearly all matching covariates[5].

Table 1 provides summary statistics of the relevant matching variables for treatment and control households before and after matching. The final sample has 2,369 observations, as some households were missing information on the matching covariates. While there are a few significant differences between the two groups, they appear to be comparable on the majority of characteristics.

Table 1: Descriptive statistics of matching variables for treatment and control households before and after matching.

Variable	Before matching				After matching				
	Treat. Mean/SE	Control Mean/SE	p-value	Bias	Treat. Mean/SE	Control Mean/SE	p-value	Bias	Reduction in Bias(%)
Household size in adult equivalent	5.75	6.23	0.000***	19.92	5.71	5.71	0.97	0.19	99.05
	0.06	0.07	.	.	0.06	0.059	.	.	.
Age of household head in years	53.71	56.05	0.000***	14.26	54.22	53.796	0.47	3.55	75.09
	0.36	0.35	.	.	0.38	0.37	.	.	.
Dependency ratio	0.88	0.84	0.196	3.11	0.86	0.843	0.56	2.81	9.79
	0.02	0.02	.	.	0.02	0.023	.	.	.
Household-head is female †	0.1	0.13	0.017**	5.31	0.1	0.079	0.13	6.34	-19.25
	0.01	0.01	.	.	0.01	0.008	.	.	.
Household-head is married †	0.89	0.85	0.003***	8.52	0.89	0.911	0.13	6.27	26.34
	0.01	0.01	.	.	0.01	0.009	.	.	.
Years of education of household-head	11.26	11.22	0.718	0.15	11.29	11.247	0.72	1.82	-1 075.47
	0.08	0.08	.	.	0.08	0.083	.	.	.
Household members (in AE) per room	1.59	1.68	0.005***	8.12	1.59	1.621	0.35	4.92	39.47
	0.02	0.02	.	.	0.02	0.025	.	.	.
Household has piped or protected water source †	0.8	0.88	0.000***	19.91	0.8	0.813	0.62	2.77	86.08
	0.01	0.01	.	.	0.01	0.012	.	.	.
Dwelling has good roof †	0.88	0.96	0.000***	25.23	0.91	0.918	0.53	4.48	82.26
	0.01	0.01	.	.	0.01	0.008	.	.	.
Household owns the house †	0.98	0.98	0.324	0.3	0.98	0.982	0.7	1.98	-556.11
	0	0	.	.	0	0.004	.	.	.
No. of observations	1 175.00	1 194.00			1 019.00	1 109.00			

Note: Dummy variables are indicated with †.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Only three variables (i.e. female household head, years of education of household head, household ownership of the dwelling) show a higher difference in mean between treatment and control after matching. However, a deeper look at the means in each group, shows a difference in years of education of just about 16 days, and a difference of 0.2% for the household ownership of the house and 2% difference in the number of female headed households. Further, an overidentification test for covariate balance is not able to reject the null hypothesis that the three concerning covariates are balanced between groups – that is, we are confident that balancing on relevant variables has been achieved using our model.

3.2 Questionnaire and impact indicators

The main data collection instruments for this impact assessment entail household and community questionnaires. Both surveys were administered between February 2018 and May 2018. The data collected refer to the twelve months preceding the survey implementation. In particular, data on agricultural production takes as reference period the last completed agricultural cycle namely the period of time between October 2016 and November 2017. The household questionnaire collected information at household level on a number socio-economic characteristics, land and assets ownership, agricultural and livestock production, access to financial services, social capital, participation to organizations and associations and migration. 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, networks and livestock measurements by breed.

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 LPDP project on the population of interest. In particular, we focus on estimating project's impacts on a set 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**.

The impact indicators have been conceptualized in five groups and have been carefully analysed as part of this impact assessment. We first analyse indicators related to economic mobility including income, assets and poverty level, we then move to livestock related components given the specific focus of the project, we then move to the environmental benefits and resilience looking at pasture rotation, we then discuss nutrition and food insecurity whereby this particular project is enriched with anthropometric measures given the direct impact that a livestock project may have on nutrition. (Ballard et al., 2013), to conclude with social capital aspects, access to market, child schooling. A list of these indicators as well as a description of their construction is included in the Appendix (**Table A2**).

3.2.1 Economic mobility: income, wealth and market access indicators

Indicators measuring economic mobility consist of:

- Annual total gross household income. This includes income from crops, livestock, agro-forestry activities, family enterprises, wage employment, and other sources (such as pensions or remittances).
- Income diversification, constructed as a total number of income sources and using the Gini and Simpson Index of diversity.
- Asset indices were 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.
- Accessibility to market proxies by amount of transactions, location, type of buyer and seller.

3.2.2 Livestock specific indicators

Indicators measuring livestock specific impacts we look at:

- Livestock assets measured as the number of livestock units owned by the household, as well as their diversification and composition;
- Milk productivity and animal weight by type;
- Breeding and reproductive practices;
- Access to services, water points, veterinary services and related costs.

3.2.3 Environmental indicators and resilience

Looking at the environmental side of impacts, although a more detailed measure should be used looking also at specific animal feed intake and consequent methane emission and normalized difference vegetation index for mapped pasture, for the moment we focus on:

- Rotational plan for pasture as a proxy of sustainable use of pasture land;
- Incidence of fodder use and other feed resources for animals;
- Presence of erosion and adoption of preventive measures;
- Measure of income and assets for households that have been affected by the most common and intense shocks namely drought, frost, health, and economic shocks which is used as a resilience measure.

3.2.4 Nutrition

To measure nutrition we report anthropometric measures as well as food security and diversity. With regard to anthropometric measures, we make use of four types of indicators:

- Weight-for-length/height z-scores
- Weight-for-age z-scores
- Length/height-for-age z-scores
- BMI-for-age z-scores

The Z-score[6] system expresses the anthropometric value as a number of standard deviations or Z-scores below or above the reference mean or median value. We use as a basis for comparison across countries the National Center for Health Statistics (NCHS) growth reference, the so-called NCHS/WHO international reference population. Constructed following the World Health Organization guidelines.

- The Household Dietary Diversity Score (HDDS) of the week and day prior the survey computed based on twelve food groups (FAO, 2010).
- 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).

3.2.5 Social capital, gender and financial management capacity indicators

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

- Participation to PUU, frequency of meetings and number of households member belonging to the Unions;
- Women's decision making power;
- Children's participation to school

[6] WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: World Health Organization, 2006.

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.[7]

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.

[7] Results using IPWRA estimators are available upon request, but are robust and consistent with results reported here.

4. Profile of the project area and sample

As already mentioned, the LPDP project was implemented in the Khatlon region of Tajikistan. According to the latest data by the National Statistics Committee, 53% of the population of the country was below the poverty line of US$1.37/day and 17% was below the extreme poverty line of US$ 0.87/day in 2007[1]. The strong growth in remittances between 2003 and 2007 accounts for about half of the observed reduction in poverty. Poverty is mainly a rural phenomenon in Tajikistan, with the rural poor accounting for 75 percent of all poor and 72 percent of the extreme poor. There are significant regional differences in the incidence of poverty. The nature of the regional differences is based primarily on the different income levels, the cost of living and the overall level of socio-economic development of the various regions. In terms of absolute indicators, however, the majority of poor people live in Khatlon and Sugd provinces, which account for 65% of Tajikistan's total population.

Non-income dimensions of poverty have shown limited progress over time. Pressure on public service delivery grew significantly after independence due to rapid population growth and reduced public spending. As a result infrastructure is of poor quality; access to electricity, heating, and safe drinking water is limited; and unofficial payments for services are high and widespread. At the same time many poor households cannot afford to pay for these utilities and Government does not have the resources to maintain these services properly. The social protection system is rudimentary, dominated by old-age and disability pensions with virtually no social assistance. A large part of the payments where they are collected for water or utilities are diverted towards discharging Government's social fund liabilities. Low levels of investment in social sectors, the poor level of salary and performance incentives have persuaded many qualified staff to leave in search of better prospective outside the country. Together, these factors have constrained access to education and health services, especially for the poor in rural areas.

The selection of the beneficiary districts of LPDP was based on poverty levels. Villages within the selected districts were considered eligible based on population and pasture characteristics, namely the number of households residing in a village and the carrying capacity of the surrounding area.

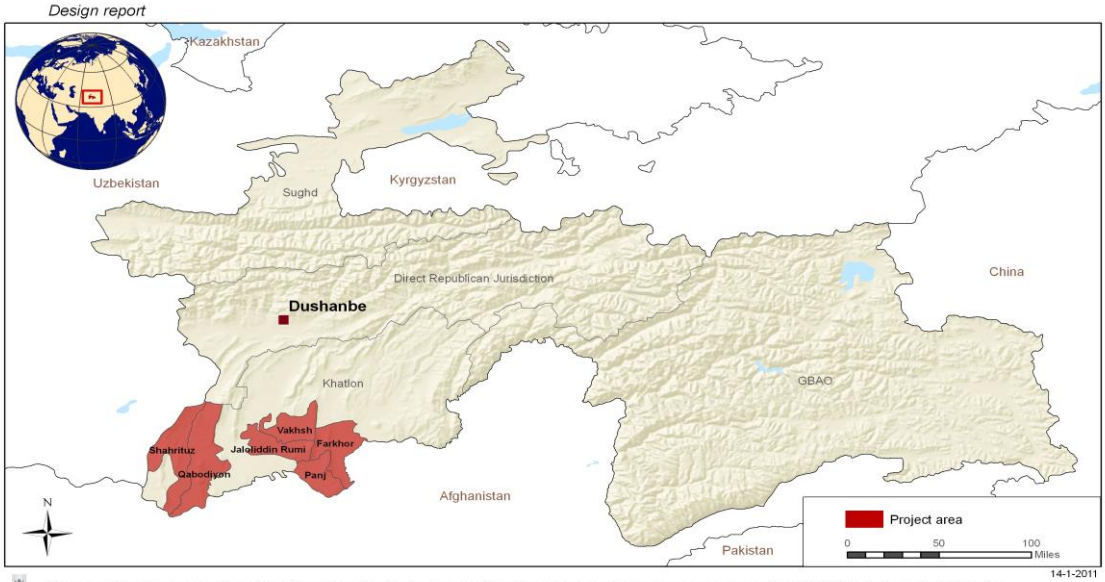
Specular targeting criteria were applied to LPDP selection of beneficiaries, thus in the districts of Baljuvon, Khovaling, Muminobod, Shuroobod and Temurmalik LPDP-I has been implemented while in Danghara, Farkhor, Hamadoni, Kulob, Vose LPDP-II was foreseen to start at a later stage.

[1] Poverty was estimated in the Tajikistan Living Standards Survey (TLSS) at 81% in 1999; 64% in 2003; 57% in 2004 and 53% in 2007 (however due to changes in methodology this estimate is not comparable with the previous estimates).

Tajikistan

Livestock and Pasture Development Project

Design report



The designations employed and the presentation of the material in this map do not imply the expression of any opinion whatsoever on the part of IFAD concerning the delimitation of the frontiers or boundaries, or the authorities thereof.

IFAD

Map compiled by IFAD

5. Results

This section presents the results of the analyses of the impact of the LPDP in accordance to the project theory of change comparing beneficiaries to the control group.

All impact estimates presented 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.

5.1 Impacts of LPDP

Economic mobility

We start by reporting results on economic mobility in **Table 2a**. Results clearly indicate that impacts are positive with regard to the two main proxies we use, namely income and assets and that they are mainly linked to livestock. Total gross income is, indeed, significantly higher for the treated group than for the control group and the same applies when we move to income coming from livestock both gross and net. When we consider income diversification strategies, which we measure using the Berger index of diversity (i.e. dominance of certain sources compared to others), and the Gini-Simpson index of diversity (i.e. evenness and the number of sources of income), we find that treated households are significantly more diversified than control households. This suggests that beneficiaries are able to also add additional sources of income to the livestock source which represents 44% for the treated group and 37% for the control group. Looking at another important source of income, namely annual gross crop income, we also find that beneficiary households report a significantly higher income than control households.

Last but not least, when considering assets measured using a polychoric factor index, which combines binary and count variables for durable and productive assets, we find that whereas durable dwelling and households assets are less for the treated than the control households, the index is inverted when we use productive assets related to livestock including shelters and sheds for animals suggesting a clear investment on animal husbandry.

Table 2a: Indicators of economic mobility

Indicators	Whole sample **Total number of observations 2262**		
	ATET	Control Mean	Treatment mean
Annual Total Gross Income USD	336.889***	1 797.004	2 112.438
Annual Gross Livestock Income USD	301.031***	568.972	867.481
Annual Net Livestock Income USD	209.090***	494.807	703.709
Annual Gross Crop Income USD	38.799***	211.493	263.465
Income diversity: Berger-Parker index	0.067***	1.734	1.787
Income diversity: Gini-Simpson index	0.070***	0.688	0.763
Share of total income from: LIVESTOCK	0.062***	0.370	0.441
Asset index for household livestock: PCA	0.627***	0.544	1.150
Asset index for household goods: PCA	-0.151***	1.729	1.521

Note: Dummy variables are indicated with †.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Livestock specific indicators and mechanisms to achieve impacts

Moving into livestock specific indicators we find that the livestock herd measured in Tropical Livestock Units[8] (TLU) of the treated group is clearly significantly higher than the control group and this applies to the total herd as well as to the breakdown into the different types of animals which is demonstrated by a significantly higher livestock diversification index measured using the Berger-Parker as well as the Gini-Simpson index of diversity[9]. Whereas this indicates that treated households are clearly better off in terms of livestock capital and type, it may also raise issues related to the feeding and nutritional aspects of livestock as well as to the carrying capacity of the pasture land.

However, when we look at the impact on milk production, we find that both the total annual quantity as well as the daily quantity of milk produced is significantly lower for the treated group than for the control group, suggesting that the feeding sources currently used are possibly not sufficient to feed a larger cattle herd. On the other hand ewes of old age as well as lamb after weaning from milk are on average heavier in the treated group than in the control group, as opposed to lamb that are lighter. Detailed animal weights are reported in **Appendix 2**, however, results show that overall adult ruminants are significantly higher in weight in the treated group than in the control group for cattle, goats and sheeps, whereas the opposite is true for young animals. This may indicate, in line with

[8] TLU, Tropical Livestock Units are livestock numbers converted to a common unit . Conversion factors are: cattle = 0.7, sheep = 0.1, goats = 0.1, pigs = 0.2, chicken = 0.01. (Harvest choice, 2005).
[9] Breakdown of herd composition by animal is also available.

results on milk production and productivity, that the animal raised are increasing meat production rather than dairy and milk[10].

With regard to the mechanisms that allow an increase in animal weight and households income we look at access to water and its cost as well as to the options offered by the PMU of accessing veterinary services and tractor use at lower costs. As a matter of fact, results show that beneficiary households have a significantly larger access to water points for animal 10.5% of the beneficiary households as compared to 7% in treated villages and that the cost of accessing the water point is significantly lower for beneficiaries than for control households. Likewise in treated villages, beneficiaries have access to tractor services at a significantly lower costs than in control villages, therefore determining a good contribution to positive economic mobility. It is important to note that data as well as qualitative analysis shows that most of the water points existing in the treated villages have been built by the project and managed by the PUU.

Another key determinant of improving livestock herd and livestock management practices is also linked to the type of reproductive system and to the breeding techniques adopted. Whereas in the case of the LPDP capacity was built around breeding practices and techniques for all types of animals, specific species improvement has focussed on improved species of sheep meant to produce higher amount of meat. Results reported in the table below confirm that significantly more beneficiary households have practiced different types of breeding techniques and controlled mating to improve animal species, indicating that capacity development and PUU have had a significant impact with regard to raising awareness of species improvement but also with regard to actually adopting practices learned.

Lastly, we look at livestock health services. Whereas we find very few veterinary points to be reported in both treated and control villages, we find that a significantly higher percentage of animals have been vaccinated or cured by treated households, indicating a higher access and perhaps awareness of vaccines, followed by higher expenditures on this practice.

Table 2b: Livestock indicators and mechanism to achieve impacts on livestock herd and income.

Indicators	Whole sample		
	ATET	Control Mean	Treatment mean
Livestock composition			
Total Livestock owned by the household (TLU) (2262 obs)	1.258***	2.085	3.294
Livestock diversity: Berger-Parker index (2262 obs)	0.441***	1.409	1.820
Livestock diversity: Gini-Simpson index (2262 obs)	0.227***	0.261	0.474
Milk production and animal weight			
Annual Total quantity of milk: PRODUCED (1809 obs)	-112.657***	745.401	642.385
Quantity of milk produced per day per animal (LT) (1809 obs)	-0.492***	3.067	2.570
Sheep – avg weight in KG (2262 obs)			

[10] Estimates on milk production and animal weights are robust and consistent across models. An additional analysis has been performed on selected locations highly similar in terms of geographical conditions (altitude and pasture), providing the same results has those reported here. These results are available upon request.

Ewes of old age (give birth >1)	7.554***	43.820	51.055
Lambs of 10 days old (male or female)	-1.230***	8.790	7.390
Cattle - avg weight in KG			
Cow after delivery or in pregnancy until 3 months (2262 obs)	62.385***	227.852	283.638
Male calf after birth (10 days old) (2092 obs)	-8.561***	32.042	21.560
Female calf after birth (10 days old) (1110 obs)	-5.864***	25.966	18.722
Mechanisms for livestock improvement			
Main source of water for livestock is WATER POINT † (2262 obs)	0.039***	0.078	0.105
Cost of the waterpoint USD (2262 obs)	-0.239**	0.653	0.234
Cost of one hectare worth of TRACTOR – USD (2262 obs)	-3.341***	38.563	35.023
Livestock was vaccinated in 2017†	0.090***	0.824	0.885
Expenditure on vaccines for livestock	23.548***	34.828	56.378
Breeding and reproductive practices			
Household has practiced controlled mating†	0.039***	0.024	0.067
Breeding strategy: BEST MALES ONLY MATED TO BEST FEMALES†	0.041***	0.020	0.063
Source of females for mating: HIGH QUALITY FEMALE LINE †	0.059***	0.004	0.063
Household avoided breeding from inferior animals †	0.033***	0.014	0.049

Note: Dummy variables are indicated with †.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Environmental indicators

The results so far reported on economic indicators are clearly showing a significant impact coming from new and improved species of animals and by better management practices and access to water. Improved species are determined both by breeding and reproductive techniques, as well as by better management and access to services. However, one matter of concern is also related to how larger and heavier herd are fed while maintaining the carrying capacity. The project meant to ensure pastureland restoration by adopting and ensuring compliance with a pasture rotational plan, to compensate which animals should receive feed from fodder cultivated plots. Nonetheless, it is to be noted that pasture rotation system also ensure that pasture use from non PUU members from other villages is avoided. Whereas a detailed analysis of mitigation potential based on livestock feeding

sources and species would require larger and more detailed data calculated using dedicated models[11], we here use proxies for land use.

As reported in the table below, a significantly higher percentage of beneficiary households adopts and complies with a rotational plan for the use of pasture (95.3% of treated households as compared to 67.1% of control households). In addition to that, more households have access to common pastureland in villages which are subject to controlled rotation. With regard to land titling, although the sample shows that the difference of titles is significant in means, it has to be noted that a very high percentage of households has land title available in both treated and control villages.

Another aspect worth noticing is that whereas 12.4% of parcels are reported as presenting soil erosion among treated households, the percentage lowers to 4.6% when it comes to control households with the difference being statistically significant. On the other hand, a larger and significantly higher percentage of erosion-affected households report adopting measures against erosion suggesting they are more aware and also more capable of adopting preventive measures against erosion, possibly thanks to capacity developed through the training provided by the project.

When we look at type of feeding practices we notice no significant increase in the use of fodder among project beneficiaries as would have been expected given the intent to reduce free grazing and increase fodder use. Looking more into details we find that there is actually less fodder used in the summer among project beneficiaries compared to the control and the difference is significant, whereas no significant difference is found on the use of fodder during the winter. Moreover, there is significantly more grazing undertaken in the summer among beneficiaries than among the control group whereas no significant difference is found in winter grazing. However they seem to mainly graze on their own land and less on protected land, suggesting they are indeed complying with rotational plans.

Table 2c: Environmental indicators.

Indicators	Whole sample (2262 obs)		
	ATET	Control Mean	Treatment mean
HH has to respect ROTATIONAL PLAN †	0.265***	0.671	0.953
# of HHs having access to common pasture in village	4.106***	14.969	19.693
Household has a TITLE for the parcel †	0.015***	0.980	0.994
Soil presents erosion †	0.087***	0.046	0.124
Hh uses preventive measures against erosion †	0.040***	0.150	0.157
Feed source is FODDER †	-0.002	0.039	0.032
Fodder feed used in summer †	-0.081***	0.155	0.049
Fodder feed used in winter †	0.019	0.581	0.597
Feeding modality in Summer: GRAZING †	0.111***	0.830	0.968
Feeding modality in Winter: GRAZING †	0.008	0.018	0.024
Feeding source in Summer: OWN LAND †	0.069***	0.233	0.268

[11] One of such examples is the GLEAM (Global Livestock Environmental Assessment Model) developed by the livestock unit of FAO. The GLEAM is a GIS framework that simulates the bio-physical processes and activities along livestock supply chains under a life cycle assessment approach. The aim of GLEAM is to quantify production and use of natural resources in the livestock sector and to identify environmental impacts of livestock in order to contribute to the assessment of adaptation and mitigation scenarios to move towards a more sustainable livestock sector.

Feeding source in Summer: RANGELANDS (PROTECTED) †	-0.057***	0.055	0.011

Note: Dummy variables are indicated with †.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

In order to test the effect of rotational plans on the level of vegetation of village pasture area, we obtained the Normalized Difference Vegetation Index (NDVI) of both control and treatment villages for the peak vegetation season of 2011 and 2017. This allowed us to perform Difference in Difference (DID) analysis which has the peculiarity of controlling for time-invariant differences in the treatment and control group and estimate the causal effect of the intervention, assuming that changes in the time-variant factors are equal across groups.

In **Table 2d** we present results of the DID analysis performed on the sample of villages obtained through a PSM using community characteristics and environmental variables such as precipitation and temperature. Results are positive, but not statistically significant. For a more precise estimate GPS coordinates of pastureland would need to be measured, something that will be allowed for the Impact Assessment of the LPDPII project where GPS coordinates are recorded and monitored. ***Table 2d: Normalised difference in vegetation index***

Normalised Difference in Vegetation Index	
Difference in difference	98.70
	(293.0)
Nb. Observations	144
R-squared	0.164
Control group mean in 2011	3751
Treatment group mean in 2011	4025
Difference between treatment and control group in 2011	274.4
Control group mean in 2017	4252
Treatment group mean in 2017	4625
Difference between treatment and control group in 2017	373.1

Note: Standard errors reported in parenthesis.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Resilience

With regard to resilience, we calculate how shock-affected households react to shocks on key indicators of welfare, namely income and assets. We run this calculation for the most severe and most reported shocks related to climate and to livelihood or economic shocks, specifically these are drought, frost, crop disease and sharp changes in prices. In each of the shocks considered we can notice that treated households are more resilient than control households, showing a higher income despite the shock in the case of drought and economic shock and no significant difference in income in the case of frost and crop disease. Treated households also report significantly higher productive inputs in all types of shocks suggesting they do not need to use assets as buffer values in case of shocks. In the case of sharp changes in prices and crop disease treated households report, similarly significantly lower households' goods. Asset specific values are aligned to the entire and non-

shocked sample suggesting that in general households do not need to erode assets to cope with shocks and that treated households are generally more resilient than control.

Table 2e: Resilience.

Indicators	Whole sample		
	ATET	Control mean	Treatment mean
Frost (558 obs)			
Annual Total Gross Income USD	65.311	1 558.765	1 751.963
Asset index for household goods: PCA	-0.044	1.463	1.462
Asset index for productive goods: PCA	0.222**	1.056	1.347
Drought (784 obs)			
Annual Total Gross Income USD	338.920***	1 671.049	1 893.124
Asset index for household goods: PCA	0.007	1.637	1.529
Asset index for productive goods: PCA	0.427***	1.101	1.485
Economic shock (1175 obs)			
Annual Total Gross Income USD	279.470***	1 674.590	1 938.964
Asset index for household goods: PCA	-0.089*	1.621	1.471
Asset index for productive goods: PCA	0.241***	1.114	1.351
Crop disease (849)			
Annual Total Gross Income USD	99.978	1 879.146	1 927.184
Asset index for household goods: PCA	-0.182***	1.717	1.500
Asset index for productive goods: PCA	0.248***	1.161	1.392

Note: Dummy variables are indicated with †.
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Nutrition

Moving into nutrition and food security, results are a big ambiguous. On one side anthropometrics measure show positive impacts on children's growth with regard to height, but not on weight for height and BMI. On the other hand when we move to food security indicators, results show that beneficiary households are significantly more food insecure than control households despite positive impacts on all measure of economic mobility. With regard to diet diversification results show less diversified diet for treated households compared to control in the last week, but not in the previous day, although the number of food items is relatively large in both groups.

Particularly interesting are the results obtained when we restrict the analysis to the sample of children below 24 months of age. In this case, the impact of the project is unilaterally positive, since the coefficient of height for age is still positive and statistically significant and there is no longer any significant negative impact on weight for age, weight for height or BMI. Moreover, considering the

timing of the intervention, these cohorts are the most likely to have fully benefitted from the project in comparison to older children.

Table 2e: Nutrition and food security.

Indicators	Whole sample		
	ATET	Control mean	Treatment mean
Anthopometric measures (1839 obs.)			
Length/height-for-age Z-score	0.377***	-1.464	-1.1
Weight-for-age Z-score	-0.012	-0.937	-0.951
Weight-for-length/height Z-score	-1.187***	0.92	-0.249
BMI-for-age Z-score	-0.554***	0.16	-0.382
Anthropometric measures- Children <24 months (596 obs.)			
Length/height-for-age Z-score	0.421***	-1.2030	-0.8775
Weight-for-age Z-score	0.111	-1.209	-1.061
Weight-for-length/height Z-score	0.145	-0.741	-0.470
BMI-for-age Z-score	-0.237	-0.652	-0.763
FIES and Dietary diversity (2262 obs)			
Food Insecurity Experience Scale score for Adults - 3 months	0.378***	2.071	2.478
Household Dietary Diversity Scale score - Last Week	-0.314***	9.035	8.8
Household Dietary Diversity Scale score - Last Day	-0.115	7.484	7.544

Access to market

Access to market measured as number of transactions are not significantly different across the two groups although being higher for the beneficiary households. When we look at the typology of market sources for input and for output, the distinction we can make is that whereas for input purchases beneficiary households tend to rely more on markets outside the village rather than on local dealers or informal markets compared to the control group, when selling outputs they do rely more on traders rather than cooperatives, though in both cases they tend to sell within the village. Access to formal market suggested by these results may indicate a higher marketing capacity for beneficiaries.

Table 2g: Access to market.

Indicators	Whole sample		
	ATET	Control mean	Treatment mean
Number of transactions (1293 obs.)	0.840	2.709	3.513
Input source - AGRICULTURAL DEALER † (1293 obs.)	-0.032***	0.036	0.003
Input purchase location - MKT OUTSIDE VILLAGE † (1293 obs.)	0.073***	0.214	0.297
Larger agr. buyer: Private trader within the village † (216 obs.)	0.152**	0.316	0.457
Larger agr. buyer: Agricultural cooperative within the village † (211 obs)	-0.132***	0.096	0.007

Note: Dummy variables are indicated with †.
* Significant at 10%;

** Significant at 5%;
*** Significant at 1%.

Social capital, education and women participation

The last indicators we analyse are related to social capital and women's participation into households' decision making. With regard to social participation we look at number of households that has at least one member belonging to the PUU or other livestock and pasture associations which represents a proxy for livestock and pasture management capacity development. As we can see significantly more households have members that participates to PUU in treated villages although the frequency of meetings per year does not significantly differ. On the other hand, more people from the beneficiary group tend to eat outside, suggesting some form of social cohesion and of bonding social capital.

Moving to women's role into decision making we can see that women have a significantly higher decision making role in beneficiary households than in control households when it comes to breeding techniques for cattle (although the number of observation here is reduced to those that apply cattle breeding techniques) as well as for deciding on agricultural earnings. Women's role is instead differentiated with regard to feeding decisions making where it is higher for small ruminants and lower for cattle compared to the control group.

With regard to women headed households (294 observations) we can see that women-headed households in the beneficiary groups report a significantly higher value of livestock income as well as of livestock herd measured as TLU, which, given the objectives of the project is a positive outcome which complies with expectations from the theory of change.

Last but not least, a positive impact is reported on schooling whereby we find a significantly higher number of years of education among the young group of the population (between 6 to 15 years old), particularly for girls as well as a higher frequency of attendance between the same age group, which represent a very positive side effect of the project which has been reported also in FGD and by various Key Informants.

Table 2h: Social capital and women participation.

Indicators	Whole sample		
	ATET	Control mean	Treatment mean
Social activities			
HH has member that belongs to PUU † (2262 obs)	0.433***	0.358	0.757
Frequency of meetings per year: PUU (1407 obs)	-0.312	3.852	3.707
HH members ate out yesterday † (2262 obs)	0.090***	0.282	0.427
HH members ate out in the last week † (2262 obs)	0.090***	0.282	0.427
Women participation			
Female hh-member t.c. of breeding cattles† (103 obs.)	0.439***	0.259	0.526
Female hh-member t.c. of feeding cattles† (2262 obs.)	-0.132***	0.793	0.690
Female hh-member t.c. of feeding	0.150***	0.172	0.322

goats† (2262 obs.)			
Female hh-member t.c. of feeding sheeps† (2262 obs.)	0.189***	0.129	0.304
Female hh-member decides on agricultural earnings† (2262 obs.)	0.021**	0.018	0.049
Women headed households			
Total Livestock owned by the household (TLU) (294 obs)	1.329***	1.724	2.852
Annual Total Gross Income USD (294 obs)	176.566	1 649.445	1 723.888
Annual Gross Livestock Income USD (294 obs)	270.039***	496.365	707.052
Annual Net Livestock Income USD (294 obs)	208.813***	446.741	574.042
Schooling (3241 obs.)			
Years of education: 6-15 y.	0.305***	3.370	3.750
Years of education: female 6-15 y.	0.166*	1.649	1.813
Years of education: male 6-15 y.	0.139	1.722	1.937
Individuals. (6-15 y.) has attended school †	0.042***	0.765	0.817

Note: Dummy variables are indicated with † (1="Yes")
* Significant at 10%;
** Significant at 5%;
*** Significant at 1%.

Conclusion

The present report presents results of the Impact Assessment conducted for the LPDP project in Tajikistan. The LPDP project targeted the poorest region of Tajikistan, Kathlon, focusing on its main income source, namely livestock, and accounting for the mountainous topography of the area. The main aim of the project was to increase the economic mobility of beneficiary households by improving livestock production and income while also accounting for the carrying capacity of the area.

To this purpose, the project selected jamoats in the region that were identified by the highest poverty rate, coupled with population size of the village and with a carrying capacity that would allow animal husbandry. The selection included jamoats as a first step and villages as a second step. Given the targeted number of beneficiaries, the results of the selection has been that all jamoats and villages that complied with the targeting criteria ended up being part of the LPDP project. Similarly, all households in participant villages were beneficiaries of the project through the PUUs. Whereas this may have presented a difficulty in selecting the comparison group, the starting of the LPDP II in other districts of the same region and adopting very similar criteria for targeting, allowed an easy selection of the control group for this impact assessment. Hence, the control group has been sourced among the beneficiaries of the LPDP II, following a three steps selection procedure that replicated the eligibility and selection criteria of the project combined with propensity score matching to include additional observable similarities at jamoat and village level, whereas within selected villages households were randomly selected.

The project presents a rather straightforward approach in that it aims to improve livestock production by strengthening the livestock species through adoption of controlled mating and of breeding techniques, as well as through the provision of improved sheep species. These outcomes should be achieved through capacity development implemented through the pasture users unions (PUU) that are associations formed at the village level and whose aim is to ensure better livestock and pasture management. As a matter of fact, to ensure the maintenance of livestock's carrying capacity and the restoration of degraded pasture it is essential to sustainably manage pastureland. A challenge that is exacerbated by an increased and healthier livestock herd obtained through the project and which must be addressed by organizing and monitoring rotational plan on the use of pastureland and yet, at the same time, increasing the fodder sources and the number of plots dedicated to fodder production.

Results of the analysis conducted show that the impact of the project on the beneficiary group are positive and significant in increasing income as well as on productive assets. This is particularly true when it refers to livestock income or to livestock related assets, but it also applies to crop income. Positive results are clearly reflected also on the larger livestock herd as well as on the weight of the animals that are part of the herd. These positive results seem to be determined by better access to water and reduced costs of water as well as of tractor services provided by the PUU, but it is also due to the adoption of improved or controlled breeding and mating techniques.

Nonetheless, these positive results are not reflected in the increase of milk production. This is possibly due to the fact that the focus of the livestock production increase is on meat rather than on milk and dairy as also expressed by lower animal weight at young age as opposed to adult age. It is important to bear in mind that compliance with pasture rotational plans without a parallel increase in the amount of fodder or other type of animal feed, may raise concern towards maintaining livestock herds whilst pasture is restored. It is also to be noted, however, that pasture rotation allows for avoiding access to pasture by non PUU members. Nonetheless a geo-referenced monitoring of the

pastureland would allow to ensure such objectives are met whilst respecting the pasture carrying capacity.

With regard to environmental impacts, whereas we have ascertained the establishment of pasture rotation and its compliance, the effects of this practice require a long time to be seen and as such the NDVI does not allow to assess any impacts on pastureland restoration as of today, although its value is positive. However, the geo-referencing of pastureland that is being conducted under the new phase of the project, namely LPDPII will allow for such an analysis. Whereas additional calculation of mitigation potential of GHG could certainly further enrich the analysis.

Interestingly we can also find positive unintended impacts from the project: freeing children 's time on livestock management and water harvesting and increasing their families' income allows them to attend school as reported by positive and significant school participation among beneficiary children and as reported from qualitative analysis conducted.

The project also meant to increase women's roles and help generate income for women headed households. Positive results are indeed found on income and productive assets among women headed households and, in general, a significantly higher decision making power on small ruminants feed, on livestock breeding and on crop income earnings.

Somewhat controversial and confusing are, instead, the results coming from nutrition and food security: whereby anthropometric measures are positive and significant showing that children of beneficiary households present a better nutrition and growth rate (height for age), the opposite is true when it comes to food insecurity and food diversification suggesting that either the FIES approach did not allow for good data given how sensitive certain questions are.

Last but not least, no clear impacts are found on access to market although the number of transactions and type of buyer seem to suggest that beneficiary households have a better access to outside and more formal market as compared to control households.

Overall the project shows positive and significant impacts on the main indicators that measure projects' outcomes, namely livestock income, size and weight which is supported by the establishment of the PUU and by developing their capacity towards sustainable livestock management. However, the increased livestock herd and size may raise some issues of concerns with regard to the carrying capacity and to the environmental benefits of the project which should be obtained through establishment of rotational plan of pastureland to which the project report compliance which are indeed being monitored and more specifically implemented under the second phase of the project.

Results of this impact assessment show that a strong logic and theory of change is reflected in the impacts of the project, while also suggesting that from phase I to phase II the project acquired a stronger focus towards natural resource management and monitoring with the purpose of achieving also GHG mitigation objectives.. Indeed, the LPDP II, of which this data collection has also provided a baseline will allow for better monitoring of the ecological footprints, given the mapped pastureland, of the project in addition to the other indicators to be measured.

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Appendix 1:

Figure A1.1: Common support between treatment and control groups

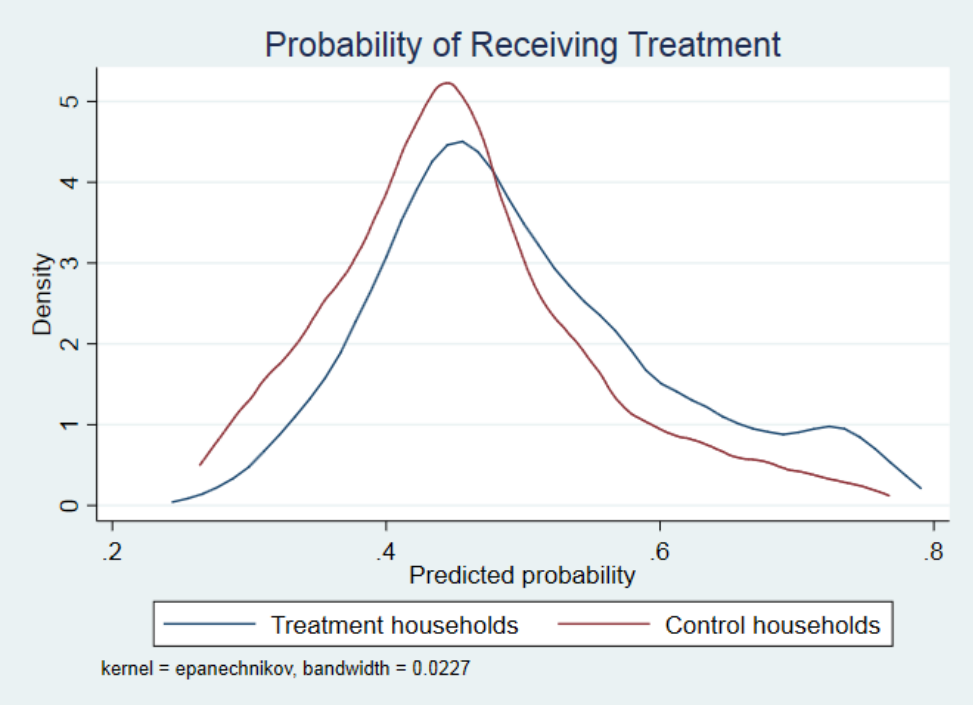


Figure A1.2: Bias reduction before and after matching

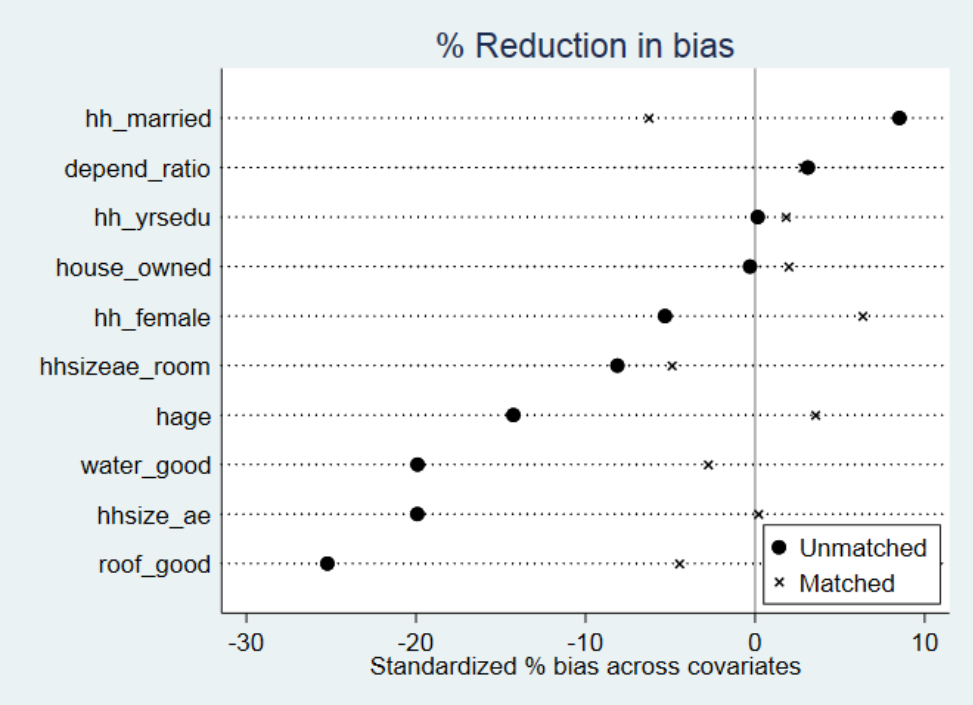
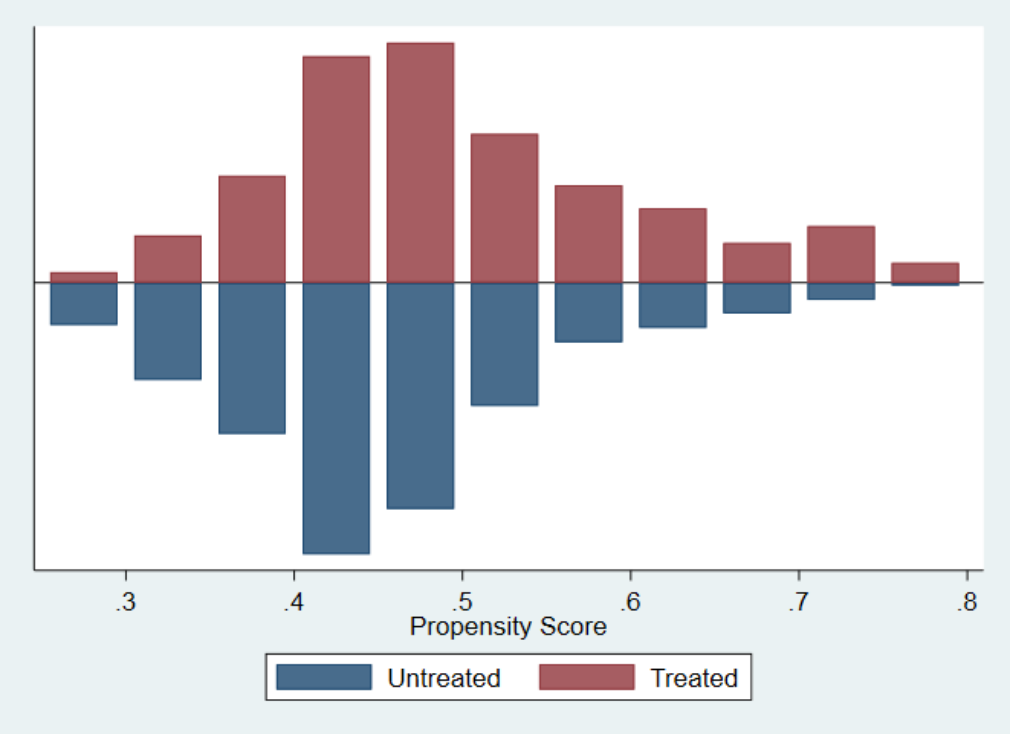


Figure A1.3: Matching histogram of treated and untreated observations.



Appendix 2:

Table A2.1 Impacts on animal weights:

Indicators	Whole sample		
	ATET	Control Mean	Treatment mean
Sheep – avg weight in KG (2262 obs)			
Ewes of old age (give birth >1)	7.554***	43.820	51.055
Lambs after weaning from milk	5.709***	18.023	23.569
Lambs of 10 days old (male or female)	-1.230***	8.790	7.390
Cattle - avg weight in KG			
Cow after the birth period or in pregnancy until 3 months (2262 obs)	62.385***	227.852	283.638
Male calf after birth (10 days old) (2092 obs)	-8.561***	32.042	21.560
Female calf after birth (10 days old) (1110 obs)	-5.864***	25.966	18.722
Bull of 1-2 years old (2262 obs)	16.633***	130.211	146.448
Heifer of 1-2 years old (2262 obs)	27.164***	134.680	162.591
Cow of more than 2 years old (2262 obs)	75.479***	170.536	244.250
Goats - Avg weight in KG			
Female goat of old age (give birth >*1)	3.398***	29.098	31.982
Offspring of 10 days old (male or female)	-0.982***	4.987	3.952
Offspring after weaning from milk	-1.242***	15.825	14.247

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