Millennium Challenge Account of Mongolia (MCA-M) Peri-Urban Land Leasing Activity

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Interim Report for Phase I Areas

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Prepared by: Innovations for Poverty Action

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Table of Contents

I. Acknowledgements i

II. List of Acronyms and Definitions iv

III. List of Tables v

IV. List of Figures vii

V. Executive Summary viii

A. Project Background and Description viii

B. Beneficiary Selection Process in Phase I Areas x

C. Data Collection xi

D. Impact Evaluation Design xi

E. Presentation and Analysis of Data from PURLS Follow-up xii

1. Expected Short-Term Outcomes xii

2. Expected Long-Term Outcomes xii

i. Short-Term Outcomes xiii

ii. Long-Term Outcomes xiii

F. Conclusion and Next Steps xv

I. Introduction 1

A. Overview of MCA-M Peri-Urban Rangeland Project 2

iii. Expected Short-Term Outcomes 6

iv. Expected Long-Term Outcomes 6

B. Selection Process in Phase I Areas 6

C. Evaluation Design 10

II. Data Collection 13

A. Contracting 13

B. Questionnaire Design and Description 14

C. Sampling Strategy & Response Rates 15

i. Baseline 15

ii. Follow-up 17

D. Data Quality Monitoring 20

III. Comparison of Peri-Urban Areas Using Soum Governor Survey 21

IV. Project Outputs and Opinions of the Project 22
V. PURP Herder Group Characteristics 26
A. Comparison of Intensive and Semi-intensive Herder Groups 26
B. Herder Group Characteristics by Area 31
C. Gender Analysis of Project Groups and Households 35
VI. Household Survey Results and Impact Analysis 40
A. Peri-Urban Rangeland Project Logic 40
B. Household Descriptive and Impact Analysis by Peri-Urban Area 46
i. Causal Pathway 1: Improved Pastureland Management 47
ii. Causal Pathway 2: Improved Animal Husbandry Practices 50
iii. Causal Pathway 3: Improved Land Tenure Security 69
C. Impact Analysis for Intensive and Semi-intensive Herder Groups 71
D. Impact Evaluation Summary 72
i. Summary of Impact on Short- and Long-term Outcomes 72
ii. Summary of Impact by Peri-Urban Area 73
VII. Conclusion and Next Steps 74
VIII. Appendices 76
IX. Bibliography 102

II. List of Acronyms and Definitions

Acronym	Definition
ATT	Average Treatment Effect on the Treated
CPR	Centre for Policy Research
DQM	Data Quality Monitors
ESA	Environmental and Social Assessment
GIS	Geographic Information System
IPA	Innovations for Poverty Action
MCA	Millennium Challenge Account
MCA-M	Millennium Challenge Account - Mongolia
MCC	Millennium Challenge Corporation
MCDS	Mongolian Center for Development Studies
MNT	Mongolian Tugrik
NSO	National Statistics Office
PIU	Project Implementation Unit
PSM	Propensity Score Matching
PURLS	Peri-Urban Rangeland Leasing Survey
PURP	Peri-Urban Rangeland Project
RCT	Randomized Control Trial
USD	United States Dollar
USDA	United States Department of Agriculture

Definitions:

Sheep Units: A "sheep unit" is a generic way of measuring "number of livestock" that takes account of the differing size of animals. Goat = 0.9, Sheep = 1, Camel = 5.7, Cattle = 6, Horse = 6.6

Dzud: Particularly harsh winters characterized by heavy snow, a coat of ice over the ground, or complete lack of snow, all of which reduce forage availability and lead to mass starvation of livestock.

Carrying capacity: The maximum number of livestock that an area of pastureland can sustainably support without becoming degraded over time.

Pasture load: The number of livestock that are actually being grazed on an area of pastureland.

III. List of Tables

Executive Summary

Table ES 1. Phase I Project Activity Timeline ix

Table ES 2. PURLS Survey Questionnaires – Types and Content xi

Report Body

Table 1. Phase I Project Activity Timeline 5

Table 2. Minimum Criteria for Short-Listing Phase I Herder Groups 8

Table 3. Criteria for Scoring Short-Listed Herder Groups 8

Table 4. PURLS Survey Questionnaires – Types and Content 15

Table 5. PURLS Baseline Household Survey – Response Number by Respondent Type 17

Table 6. PURLS Follow-up Household Survey – Response Number by Respondent Type 19

Table 7. Selected Statistics from Soum Governor Survey 21

Table 8. Ranked Importance of PURP Components 25

Table 9. Number of Project Herder Groups in Phase I[1] 27

Table 10. Number of Project Households Interviewed for PURLS[1] 27

Table 11. Comparison of Group-level Characteristics, by Intensive and Semi-intensive 27

Table 12. Comparison of Household-level Characteristics at Baseline and Follow-up, by Intensive and Semi-intensive 29

Table 13. Percent of Project Households Owning Each Type of Animal, by Intensive and Semi-intensive 30

Table 14. Types of Animals Owned by Project Households, by Intensive and Semi-intensive 30

Table 15. Group Composition & Demographics of Members 32

Table 16. Pasture Carrying Capacity and Pasture Load (Sheep Units)[1] 33

Table 17. Percent of Groups Maintaining Herd Size Below the Carrying Capacity of their Lease Area 33

Table 18. Features and People in Proximity of Lease Area 34

Table 19. Gender of Head of Household, Interview Participants, and Herder Group Leader 35

Table 20. Demographics and Basic Household Characteristics, by Gender of Household Head 36

Table 21. Percent of Households Below Poverty Line, by Gender of Household Head 37

Table 22. Average Household Income, by Gender of Household Head 37

Table 23. Investment in Immovable Property, by Gender of Household Head 38

Table 24. Investment in Livestock in Past Two Years, By Gender of Household Head 38

Table 25. Herd Size (Sheep Units), by Gender of Household Head 38
Table 26. Pastureland Related Conflicts, by Gender of Household Head 39
Table 27. PURP Detailed Project Logic with Associated PURLS Measurements 43
Table 28. Project Impact: Average Number of Moves per Year 48
Table 29. Project Impact: Herd Size (Sheep Units) 49
Table 30. Project Impact: Perceived Pastureland Quality[1] 50
Table 31. Project Impact: Change in Herd Composition (Share of Each Animal in Total Sheep Units) 52
Table 32. Effects of Hay Feeding and Cow Breed on Milk Yield 53
Table 33. Project Impact: Hay and Fodder Production and Usage 54
Table 34. Project Impact: Net Earned Income and its Components, Darkhan Peri-Urban Area[1] 58
Table 35. Project Impact: Net Earned Income and its Components, Erdenet Peri-Urban Area[1] .. 59
Table 36. Project Impact: Net Earned Income and its Components, Ulaanbaatar Peri-Urban Area[1] 60
Table 37. Project Impact: Milk Sales, Darkhan Peri-Urban Area 62
Table 38. Project Impact: Milk Sales, Erdenet Peri-Urban Area 63
Table 39. Project Impact: Milk Sales, Ulaanbaatar Peri-Urban Area 65
Table 40. Project Impact: Milk Yield per Cow (Alternative Measure) 66
Table 41. Project Impact: Animal Mortality Rates 68
Table 42. Project Impact: Investment and Infrastructure 70
Table 43. Project Impact: Pastureland Conflicts 71

IV. List of Figures

Executive Summary

Figure ES 1. Geographical Scope of the Peri-Urban Rangeland Project x

Report Body

Figure 1. Geographical Scope of the Peri-Urban Rangeland Project 5
Figure 2. Example of Land Tract Map 7
Figure 3. Example of Modified Land Tract Boundary 10
Figure 4. Balance Tests 13
Figure 5. Herder Groups Receiving Materials 23
Figure 6. Project Households Perceptions of the Usefulness of PURP Trainings[1] 24
Figure 7. Project Households Perceptions of Rangeland Leases (%) 25
Figure 8. Breakdown of Animal Types in Herd, for Intensive and Semi-intensive Households . 31
Figure 9. Number of Seasonal Camps, by Gender of Household Head 36
Figure 10. Motivations for Joining PURP, by Gender of Household Head 39
Figure 11. PURP Logic Framework 41
Figure 12. Number of Seasonal Camps at Baseline, Project Households 47
Figure 13. Animal Composition of Herds at Follow-up, Project Households 51
Figure 14. Breakdown of Livestock Revenue at Follow-up, Project Households 55
Figure 15. Breakdown of Livestock Costs at Follow-up, Project Households 56
Figure 16. Mortality Rates of Each Animal Type at Baseline 67

V. Executive Summary

The Millennium Challenge Corporation (MCC) funded the Millennium Challenge Account-Mongolia (MCA-M) Peri-Urban Land Leasing Activity, commonly known as the Peri Urban Rangeland Project (PURP), to help the Government of Mongolia shift to more sustainable rangeland management. PURP in coordination with soum and bagh officials provided exclusive pastureland use rights to herder groups and promoted improved animal husbandry practices, including sustainable pastureland management and adoption of "intensive" dairy farm practices among the project participants. The shift in practices that are anticipated to result from this project is expected to increase herd productivity, decrease land degradation and ultimately raise herder income. This follow-up report for Phase I of PURP has three primary objectives:

1. To describe the Peri-Urban Rangeland Leasing Survey (PURLS) and research design;
2. To present the data that was collected via PURLS in order to make the data available for other research efforts and the planning of other programs; and
3. To compare matched project and non-project households in order to get an estimate of the short-term impacts of PURP on participating herder households.

This report presents the preliminary findings of the PURP Phase I impact. It should be noted that the project impacts are expected to manifest over a period of several years, therefore this report should not be considered as the final interpretation of the project impact. Moreover this survey was taken while project activities were still ongoing in early 2013 and so will necessarily miss all impacts of project activities that occurred after the survey.

A. Project Background and Description

The main goal of the MCA-M PURP is to improve the livelihoods of semi-nomadic herding households living in the areas surrounding Mongolia's larger cities. Since the transition to a market economy in the 1990s, the number of livestock in Mongolia has more than doubled, putting a strain on the common use grasslands in peri-urban areas. Overgrazing has led to severe degradation of the rangeland, on which these herders depend. By giving herders long-term rights to the land, including the ability to exclude use by other herder groups, MCA-M expects that the herders holding rights to an individual plot will have greater incentives to reduce over-grazing and make long-term investments in the land and their herds. The MCA-M PURP includes the following four components, a timeline for which is provided in Table ES 1 below;

1. *Legal reform:* To draft new legislation regarding rangeland and pasture use.
2. *Pastureland leases:* Provided 15-year exclusive-use pastureland leases to groups of herder households. This was preceded by mapping the rangeland surrounding the three peri-urban areas targeted by the study along with their associated resources and geographic, climatic and biological features. Maps were used to identify candidate lease areas.
3. *Provision of Infrastructure:* Provided herder groups with wells, materials for the construction of winter shelters and fences, and alfalfa seed. Part of the costs of these materials is to be paid back by the herder groups over a 15 year period.
4. *Provision of Training:* Provided herder groups and local officials with extensive trainings in herd and pastureland management, animal husbandry and marketing.

Table ES 1. Phase I Project Activity Timeline

Activities	Start	End
Herder Group Application and Selection	Oct-09	Sep-10
Lease signed-237 Herder Groups signed leases[1]	Sep-10	Mar-11
PURLS – Baseline	Sep-10	Jan-11
Well Installation	Apr-11	June-13
Herder Group Training	May-11	July-13
Supplying Materials for Shelter and Fence Construction	Dec-11	Mar-12
Supplying Seeds for Plantation	Feb-12	Jun-12
PURLS – Follow-up #1[2]	Dec-12	Apr-13
End of compact	Sep-13	-
PURLS – Follow-up #2 (planned)	Dec-16	Feb-17

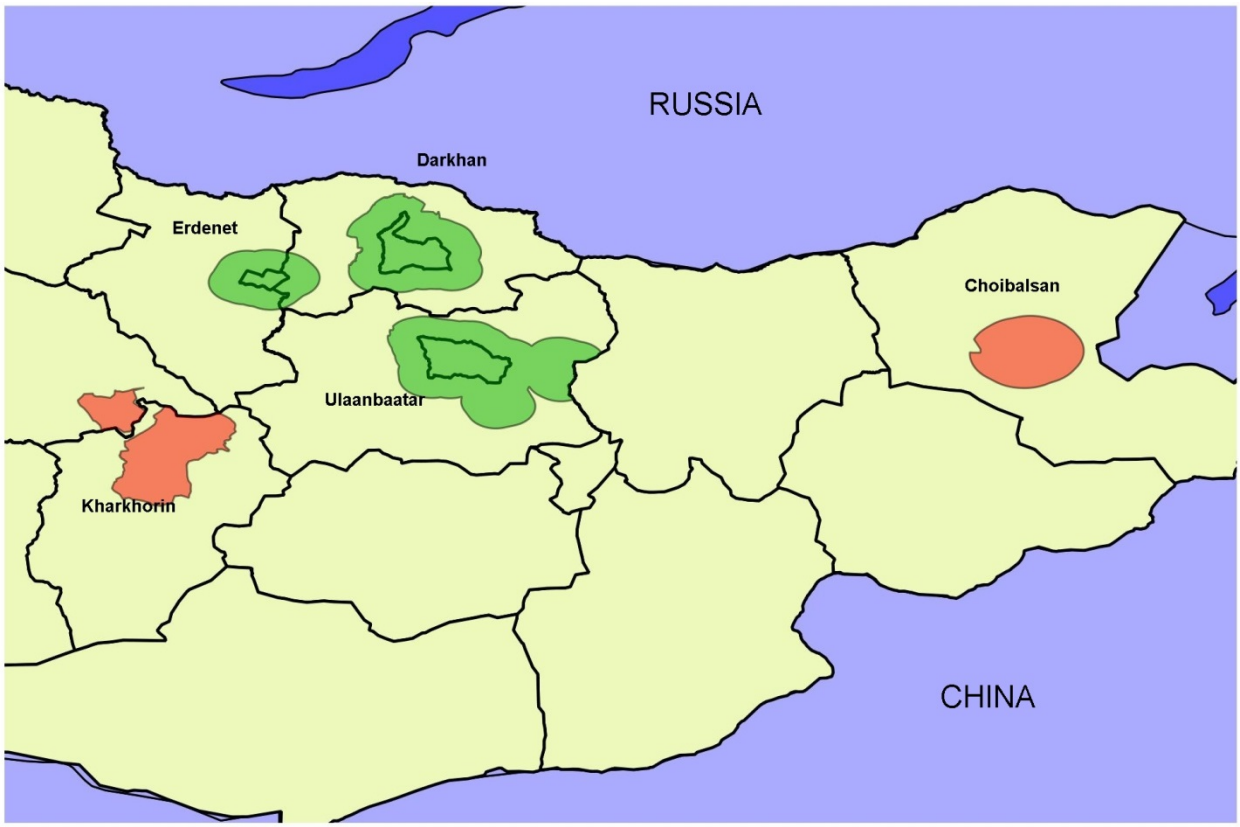
[1] 237 HGs signed leases but 234 remained at time of follow-up.

[2] PURLS Follow-up #1 occurred while well installation and training activities were still ongoing

The MCA-M PURP was implemented in two phases. Phase I of the project, which is the focus of this report, began awarding pastureland leases in September 2010 in areas around Mongolia's three largest cities: Ulaanbaatar, Erdenet, and Darkhan.[1] Phase II began one year later, and concentrated on areas surrounding two of Mongolia's smaller regional cities, Choibalsan and Kharkhorin. The geographic scope of the project is shown in Figure ES1. In this report, we will analyze the project's impacts in Phase I areas, focusing mainly on short-term changes in behavior such as herd management and rangeland use, as well as taking a preliminary look at longer-term impacts on outcomes such as household income.

[1] Preliminary activities of the project began in 2008, while direct assistance to herder groups began in 2010.

Figure ES 1. Geographical Scope of the Peri-Urban Rangeland Project



Note: Phase I areas (Ulaanbaatar, Darkhan, Erdenet) are in Green. Phase II areas (Kharkhorin and Choibalsan) are in Red.

B. PURP Beneficiary Selection Process in Phase I Areas

The process for selecting herder groups to participate in the project began in March of 2009 when PURP hired a local contractor, Centre for Policy Research (CPR), to investigate, identify, and map potential rangeland tracts within approximately 30 km radius of Mongolia's three main urban centers, Ulaanbaatar, Darkhan and Erdenet. The primary criteria included access to well water within an average depth of 50 meters of the surface, regular usage by local herders, and sufficient pasture and forage area to support herder project activities.

The deadline for herder group applications was October 15, 2009. Six hundred and seventy-six herder groups applied for leases and project assistance. Initially it was planned that applicants would be assigned a slot in the project through a lottery process, which would allow for a very rigorous evaluation of the project effects.[2] However in the end this was not possible because the number of eligible applications was too small. The applications went through a lengthy process of scoring by soum selection committees, field review to verify eligibility of land tract for the project, and review by MCC and MCA Environment and Social Assessment. At the end of this process (and after withdrawal from the project of the districts of Ulaanbaatar) only 237 potential project herder groups remained, and all of these groups were offered lease contracts and project assistance.

[2] A lottery process to assign project participation was eventually used for Phase II of PURP.

Between the baseline and follow-up survey, three herder groups dropped out, leaving 234 in the project.

C. Data Collection

The Peri-Urban Rangeland Leasing Survey (PURLS) is the key data collection activity, designed to collect basic socio-economic figures as well as information on key herding related outcomes from the households participating in the study. As an extension, the PURLS data collection also gathers information at the group and soum (county) level through surveys of the leaders of herder groups and local officials. Three separate data collection instruments – the Household Questionnaire, the Herder Group Leader Questionnaire, and the Soum Governor Questionnaire – were developed to collect information from these different levels. The content of these three surveys can be seen in Table ES 2 below.

Table ES 2. PURLS Survey Questionnaires – Types and Content

Household Survey	Herder Group Leader Survey	Soum Governor Survey
• Household expenditure and income • Loans, support and assistance received • Migration patterns • Infrastructure & pastureland quality at seasonal camps • Household livestock information • Livestock hay-making and fodder production and purchases • Land disputes • Future investments • MCA Peri-Urban project activities and opinions	• Basic herder group information • Information on herder group members • Details on transition to intensive or semi-intensive herding • Lease area information • Herder group joint business activities	• Demography and migration in Soum • Services available • Soum-wide livestock and land information • Land disputes • Donor programs and development projects

Baseline data collection began in September 2010, before the start of project activities, and interviews were taken from 3273 households. Follow-up data collection, the subject of this report, was undertaken by MEC and Mongolian Center for Development Studies (MCDS), local Mongolian firms contracted by MCA-M, starting in December of 2012 and was completed in late April of 2013. Interviews were conducted in person. In total, 84 percent of targeted households completed a full follow-up household interview. The response rate for the Herder Group Leader survey was 93 percent, while all 72 targeted soum governors were successfully interviewed.

D. Impact Evaluation Design

As described in the PURP Phase I baseline report[3], significant differences exist between households that were selected to participate in the project and those that were not. Under the

[3]"Peri-Urban Rangeland Project (PURP) Baseline Report for Phase I Areas." Innovations for Poverty Action Report to the Millennium Challenge Corporation, (2012).

original plan of randomly assigning project households from the set of applicants through a lottery, the random nature of the selection process would have ensured that among the applicants, those chosen to receive the project would have been similar, on average, to those that did not. However, since this plan was not feasible in practice, the differences observed between project recipients and the other groups in the baseline survey complicate the interpretation of any post-program differences between the project recipients and the other groups. Post-program differences might be the result of the project, but they also might be the result of the baseline differences—observed or unobserved—between the groups of households. As we outline in the PURP Phase I design document, the solution we employ is one in which we match project households with non-project households that are as similar as possible on a large range of characteristics. Such a design is not ideal, but in consultation with MCC, it was decided that such a design was the best and most rigorous option feasible given the implemented selection process.

E. Presentation and Analysis of Data from PURLS Follow-up

The following section presents the main findings from the PURLS follow-up data collection. During PURP development, stakeholders established a logic framework that laid out expectations for short and long-term project impacts. The evaluation focuses on the outcomes outlined in the project logic since these are where the largest changes are anticipated. However, other outcomes will be examined for potential unintended impacts, particularly after the second follow-up survey, which will be conducted nearly two years after the end of the project. The main project outcomes that the evaluation expects to find are split up into short and long-term:

1. Expected Short-Term Outcomes

- Increase tenure security
- Decrease in stocking rates and improved grazing practices to maintain carrying capacity of land
- Improved herd composition, particularly an increase in foreign breed and crossbreed milking cows
- Increase in hay production, hay storage, and use of hay and other prepared fodder

2. Expected Long-Term Outcomes

- Higher livestock productivity
- Decreased herd mortality
- Increased income from livestock
- Improved pasture quality due to reduction in overgrazing

The detailed logic framework can be found in Section VI.A of the report. At this point in time in the project activity, we expected to observe changes to some of the short-term outcomes. These short-term outcomes are largely measuring whether herders have adopted improved herd management practices per training provided. We did not expect to observe changes to the long-term outcomes at this point in time.

We present our findings broken down by the three project areas. A handful of the key outcomes covering each component of the project logic are summarized in this Executive Summary; a more complete analysis is provided in Section VI of the report.

i. Short-Term Outcomes

Decrease in stocking rates/maintaining carrying capacity of land

Information about herd size is an important indicator when evaluating the PURP to see if herders' behavior is changing when it comes to maintaining the correct carrying capacity. Overall the percentage of herder groups that were maintaining their herd size (as measured by the PURLS household survey) below the official carrying capacity remained approximately the same between the baseline and follow-up surveys, though the number increased in the Darkhan area and decreased in the Ulaanbaatar area. When formal impact analysis was performed using the household survey, there was a significant reduction in herd size among project households in Ulaanbaatar area, and an increase in herd size among semi-intensive project households in Erdenet.

Improved herd composition including increase in crossbred cows and other more productive cow breeds

A key goal of the project was to promote the herding of higher quality animals to improve yields without requiring large herds. The main livestock promoted were foreign breed milking cattle, referred to as "improved breeds." Project households significantly increased the representation of improved breed cattle in the herds compared to comparison households, and this result was seen in all three peri-urban areas. This is the strongest and most robust project impact observed at the time of the follow-up survey. They also reduced the proportion of goats in their herds, in all three areas.

Increase in hay production, hay storage and use of hay and other prepared fodder

In all three areas, the percentage of project households that grew their own fodder crops increased significantly relative to comparison households. Moreover, in Darkhan area, project households also increased their haymaking activities relative to comparison households, and increased the number of days that they fed their cattle with hay or fodder, while in Erdenet project households became less likely to make hay.

ii. Long-Term Outcomes

Improved pasture quality due to reduction in overgrazing

In Darkhan and Ulaanbaatar areas, project households perceived that the land quality at their winter camp improved significantly relative to comparison households. However, since it is simply a perception, this cannot be considered an objective measure of actual land quality. Much stronger information about changes in land quality will be available in the future through a separate Land Quality survey conducted in collaboration with the United States Department of Agriculture (USDA). However, more than any other outcome, land quality is *not* expected to improve measurably for several more years.

Higher livestock productivity

There were no significant project impacts found on livestock productivity, as measured by yearly milk yield per milking cow, and this result was robust across two measures of milk yield. This was somewhat surprising given the significant increase in improved breed cattle relative to Mongolian cattle in all three areas, given that improved breed cattle are supposed to produce much higher yields of milk. However, it may be that the transition was too recent to begin seeing the higher productivity of fully-producing adult improved-breed cows.

Increased income from livestock

There was little evidence at the time of the follow-up survey of project impact on household incomes. In particular in none of the areas was there a significant impact on net earned income or net income from livestock, though in Erdenet area project households increased their revenues from selling animals relative to comparison households. In contrast, the project households did significantly increase the costs of their livestock operations relative to comparison households in both Erdenet and Ulaanbaatar areas.

Decreased herd mortality

The change in herd mortality was not examined in this report because the seasonal variation in herd mortality makes meaningful inter-temporal comparisons impossible between these surveys. In particular, the baseline survey was conducted after a dzud year, where extremely harsh winter weather leads to mass die-off of livestock, while the follow-up occurred during a more normal winter. However the mortality rates at the time of the follow-up survey were compared between project and comparison households, and there were significant, statistically detectable differences in mortality rates for sheep and goats in both Erdenet and Ulaanbaatar areas. In all four cases, and especially in Erdenet, the Project households had lower mortality rates than Comparison households. For both types of animals in Erdenet, Project households had less than half the mortality rate of comparison households.

Increase tenure security

One measure of the security of a household's claim to the land they use is the number of reported land conflicts. In Ulaanbaatar only, project households experience an increase in pastureland conflicts relative to comparison households between the baseline and follow-up surveys, though the effect is not statistically significant. One possible explanation for the relative increase in conflicts for project households in Ulaanbaatar area is that leases give the herders a sense of ownership over their land that causes them to be more assertive in demanding their exclusive rights, which could result in conflicts. Another explanation is that due to more recent in-migration in the Ulaanbaatar area, and the novelty of the land leases, PURP beneficiaries simply encountered more herders that were ignorant of the project, which led to more conflicts. In either case this is expected to be a short-run effect that will reverse in the future.

Increased Investment in Improvements on the Land

Project households in both Darkhan and Erdenet areas increased their level of investment in immovable properties (housing and other structures) relative to the comparison households. There was no evidence of a similar pattern in Ulaanbaatar area, perhaps due to the still uncertain tenure security which was evidenced by the increased number of pastureland conflicts in that area.

F. Conclusion and Next Steps

As we discuss extensively in Section VI, there is some evidence from the PURLS Phase I follow-up data that herder behavior is changing. Again, this behavioral change is a necessary condition for other more fundamental effects to take place, such as increases in income. The data indicate both positive and negative effects but further analysis is needed to better understand project results. Positive results relative to Comparison households were found in specific areas of interest, particularly a shift in herd composition toward improved breed milking cows, reduced herd size, reduced mortality of sheep and goats, increased likelihood to grow fodder crops, and increased investment in immovable property. The shift toward improved breed cattle and more use of fodder is a crucial short-term behavioral impact that is expected to produce large returns in the form of higher income in the future. Many other variables are showing hints of project impact but at this point the differences do reach conventional levels of statistical significance. The only notable negative result is a possible (and statistically weak) increase in conflicts, which is isolated to Ulaanbaatar area. We want to stress several points for analysis moving forward:

1) External validity may be quite limited because most herders in Mongolia do not live in peri-urban areas, and because the group of herder households who received leases had to pass a stringent set of requirements, in particular with regards to occupying land that was not under conflict. It is unclear how many groups exist that would have similar characteristics. Moreover, there are few "intensive," western-style dairy operations in Mongolia and many project impacts were strongest for this group. Because the baseline survey collected data from a random sample of herder households in the project areas, an analysis of the characteristics of project and representative non-project households at baseline is possible, but that analysis has not yet been carried out.
2) The length of time between baseline and follow-up may simply not be long enough to observe changes. It is likely that many of the measures we are studying take much longer to materialize.
3) As we describe above and in the design report, the research design in the Phase I areas of the PURP poses a number of challenges in terms of identifying and attributing project effects. In the Phase II areas, a much stronger design with a randomized controlled trial promises to provide data with which it will be less challenging to uncover project effects.
4) IPA recommends waiting at least three to five years after the end of the compact for an additional round of data collection, which should allow for the best understanding of project impacts, as the effects are likely to continue to grow as time goes on, and the survey attrition rates have been very low. The current plan is to collect a second wave of follow-up household surveys in winter of 2016/17.
5) For future waves of data collection, numerous changes and additions to the survey instruments will be required in order to more effectively measure changes in all of the key outcomes associated with the project logic. The analysis in Section VI makes clear which questions must be added and improved in order to conduct a more complete and thorough analysis of project impact. Many of the necessary changes have already been incorporated into the PURLS Phase II Follow-up Survey, which was completed in 2014.

I. Introduction

A steady stream of poor rural Mongolians are abandoning traditional nomadic herding practices and migrating closer to cities in search of better lives. The bulk of these migrants are moving to Mongolia's three biggest cities – Ulaanbaatar, Erdenet, and Darkhan – where they either settle in underdeveloped urban areas, called ger districts, or peri-urban pastureland areas. In peri-urban pasture lands, Mongolia's current system of open access pasture use, combined with an increase in migrants' herds, has led to significant overgrazing and land degradation. In response, there has been growing interest in new strategies to encourage sustainable pastureland use.

From 1924 until 1991, Mongolia was controlled by a communist government, which collectivized the majority of herding activities. Individual households primarily herded government livestock and were paid a salary, and herd size and composition, and seasonal migrations were decided by the government.[4] As a result of centralized control, the number of livestock in Mongolia stayed relatively stable from the 1950s to the 1990s. In the 1990s, Mongolia switched to a market based economy and the majority of the country's livestock was privatized. However, rangeland remained state property that could not be privately owned, and the right of herders to use these lands is stipulated in the constitution. Moreover, after the democratic transition, no formal structure for collectively manage pastureland was created to replace the herding cooperatives, which led to a lack of coordination among the many now-independent livestock herders.

The combination of open pastureland usage and private livestock ownership has led to a situation akin to that described in ecologist Garrett Hardin's classic 1968 article, "The Tragedy of the Commons".[5] The idea is that individuals acting in their own self-interest lack incentives to limit the grazing of their herds on the land, despite the fact that doing so is in the long-run common interest to prevent the resource in question – the rangeland – from being depleted. The problem arises because the benefits of grazing one's herd on the common land are private, while everyone shares the costs associated with overgrazing. Thus, individual herders have an incentive to increase their herd sizes to levels not sustainable by the land. The number of livestock in the country has more than doubled in the two decades since the fall of the Soviet Union. In many areas of the country, in particular the peri-urban areas surrounding Mongolia's larger cities, there is perception among many stakeholders that the increase in livestock numbers has exceeded the biological carrying capacity of the rangeland and has thus contributed to further rangeland degradation and desertification.[6,7] The degraded pastureland, in conjunction with several extremely harsh winters (*dzud*) since 1999, has also led many herders to abandon the herding lifestyle and migrate to Ulaanbaatar, which has quickly swelled to a population too large to be supported by the city's infrastructure.

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[4] Fernandez-Gimenez, M.E. (1999). Sustaining the steppes: A geographical history of pastoral land use in Mongolia. Geographical Review, 89, 315–342.

[5] Hardin, Garrett. 1968. The tragedy of the commons. Science 162: 1243-48.

[6] "Carrying Capacity" is usually defined as the maximum number of livestock possible on a given piece of land, while still allowing for maintenance or improvement of the production of vegetation or related resources. It may vary from year to year on the same area due to climate and other factors.

[7] For a review of literature and assumptions regarding Mongolian rangeland degradation, see: J. Addison , M. Friedel, C. Brown, J. Davies and S. Waldron. (2012) A critical review of degradation assumptions applied to Mongolia's Gobi Desert. *The Rangeland Journal* 34(2) 125-137

One of the goals of Millennium Challenge Account with Mongolia (MCA-M) was to directly address these challenges, conserving pastureland, increasing household income and reducing poverty through changes in property rights. Through the Peri-Urban Land Leasing Activity, commonly known as the Peri Urban Rangeland Project (PURP),[8] MCA-M provided herder groups with long term, exclusive use leases of rangeland plots; training in rangeland and herd management; and infrastructure in the form of wells and materials for fences and animal shelters. The project also provided support and training to herder groups operating or planning to switch to "intensive" livestock management, which is essentially western-style dairy farming based on heavy use of prepared fodder and indoor animal shelters. By giving herders long-term exclusive grazing rights to the land, MCA-M anticipated that the groups holding rights to an individual plot would have greater incentives to reduce over-grazing and make long term investments in the land and their herds. As a consequence, MCA-M expected the project to cause improvements in land and herd quality, which over time would increase the productivity and income of herder groups awarded these rights.

In this report, we will analyze the project's short-term impacts in Phase I of the PURP, consisting of the areas surrounding Mongolia's three largest cities: Ulaanbaatar, Erdenet, and Darkhan. We will focus mainly on herders' behavioral changes regarding herd composition and management, and rangeland use, as well as taking a preliminary look at longer-term outcomes such as increased household income. In the remainder of the report, we proceed as follows. In the remainder of Section I, we provide a description of the project and expected outcomes, an overview of the methodology MCA-M used to choose beneficiary herder groups, and the evaluation design. In Section II we describe how the sample for the survey was selected and how the survey was conducted. In Section III the three peri-urban areas that make up PURP Phase I are compared. Section IV reports on direct outputs of the project and households' perceptions of the project. Section V examines the PURP beneficiary herder groups in detail, from three different angles. Results from the Household Survey, including impact analysis, are presented in Section VI, organized along the lines of the project logic. Finally, conclusions and next steps are presented in Section VII.

A. Overview of MCA-M Peri-Urban Rangeland Project

The MCA-M PURP was an innovative project designed to address the problem of overgrazing caused by the increase in herd sizes and migration closer to urban areas in Mongolia. The project consisted of the following four major activities:

1. *Legal reform:* A panel of pastureland and agriculture experts was convened to help draft a new pasture use law. The law will modify the open-range land use regime of Mongolia and establish an improved, national legal vehicle through which long-term leasing right to pastureland can be extended to private herder groups. Regulatory and enforcement mechanisms will also be created as a corollary to the law, which will standardize land use regimes across regions and allow for more consistent and transparent enforcement of the leasing rights. Although work on this component began well before any of the other project activities, to date the Mongolian parliament has not approved the passage of the draft law.

[8] The Peri Urban Land Leasing Activity, commonly known as the Peri-Urban Rangeland Project (PURP) is one of the three activities of the larger Property Rights Project, but has been implemented as a stand-alone project by MCA-M.

The original rangeland law has been incorporated into a more general land law that, at the time of publication of this report, has yet to be voted on by parliament.

2. *Pastureland Leases:* In combination with local officials, the Ministry of Food, Agriculture and Light Industry, and a key implementation contractor, Center for Policy Research (CPR), MCA-M developed a 15-year lease for pastureland to be offered to groups of herder households.[9] These leases are contracts between the herder groups and the local soum governments.[10] The contracts that govern these rights are designed to create strong incentives to invest in the land's productive capacity, and should lead to a reduction in land degradation by incentivizing herder groups to prevent overgrazing on the leased land. Other key aspects of this activity included:

   – *Rangeland mapping:* The rangeland of the peri-urban areas was mapped along with their associated resources and geographic, climatic and biological features, and used to create a rich set of GIS files. These were provided to the Administration of Land Affairs Geodesy and Cartography (ALAGaC) and regional land offices. These maps were used to determine those areas most affected by land degradation and which rangeland tracts were best suited for project activities.

   – *Intensive livestock management:* The project attempted to target "intensive" herders, who practiced or planned to practice western-style dairy farming, which is heavily reliant on prepared fodder and thus less dependent on large areas of pasture. Since intensively herded cattle rely more on hay and other prepared fodder instead of pasture feeding, and produce more milk, they exert lower grazing pressure on pastureland for a given amount of milk production. Leases cover an average of 781 hectares for groups classified as "semi-intensive" and 361 hectares for groups classified as "intensive."[11] Intensive groups also received their leases for all four seasons since they are typically sedentary, while the other groups received two- or three-season leases (winter-spring or fall-winter-spring).

3. *Provision of Infrastructure:* The project provided direct assistance to the herders to invest in their leased land through the following activities:

   – *Installation of wells:* As part of the project, every selected herder group had a well installed if they chose to, and if well drilling was deemed feasible after a technical study. The households were trained in the use and maintenance of the well.

   – *Provision of Fence and Shelter Materials:* Herder groups also were provided with materials for the construction of winter shelters, feeding equipment, and fences. The amount of money allocated to supply materials per herder group wasn't nearly

[9] Groups consisted of between two and seven herder households.

[10] A soum is roughly equivalent to a US county and is an administrative subdivision below the aimag (province) level.

[11] These averages are for herder groups in Phase I of the project, which is described below.

enough to build a complete shelter. Therefore, herder groups made their own investments to finish building their shelters.

- *Provision of Alfalfa Seed:* Herder groups who received permission to plant fodder on their leased land from their local governments were eligible to receive seeds to plant fodder.

- *Repayment*: Herder groups will be required to pay back approximately 50 percent of the value of the funds used to install the wells (up to a limit) and 100 percent of the value of the construction materials. The repayment terms are generous: no interest will be charged over a 15 year period. These will be paid to the local "soum development funds" which are used to support soum residents in need of financial assistance and to develop local infrastructure. The payment plan was designed to familiarize herders with making regular payments, since any future land-leasing systems will likely require payment of land-use fees.

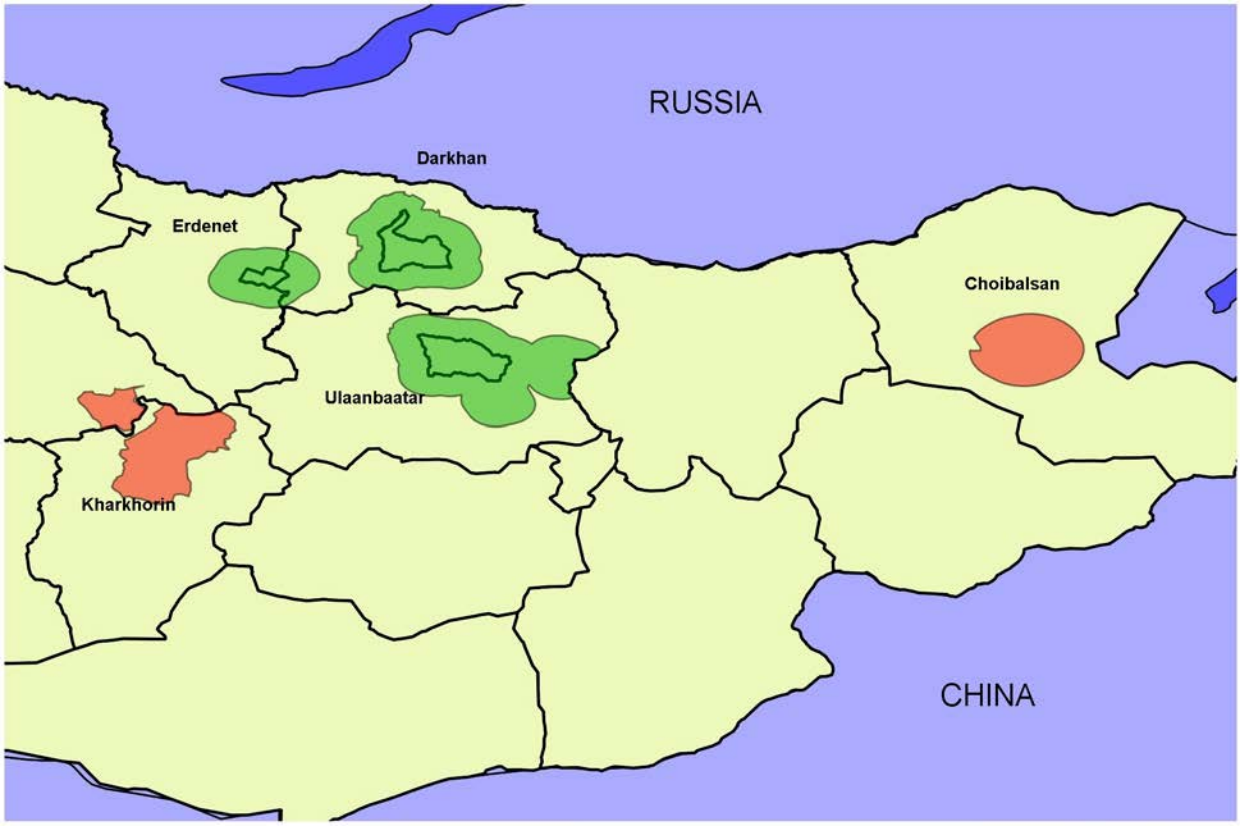
4. *Provision of Training:* Herder groups and local officials received an extensive series of trainings centered on five main topics:

    - Leaseholder rights, commitments, and responsibilities
    - Rangeland, environmental and water resource management
    - Livestock management and productivity
    - Livestock business management and marketing of animal products
    - Collaborative management of herds, pasture, and forage

The MCA-M PURP is to date one of the largest and best-funded efforts designed to address the issues of rangeland degradation and income loss due to overgrazing. The MCA-M PURP was implemented in two phases. Phase I of the project, which is the focus of this report, started issuing leases in September 2010 in areas around Mongolia's three largest cities: Ulaanbaatar, Erdenet, and Darkhan. Phase II began one year later, and concentrated on areas surrounding two of Mongolia's smaller regional cities, Choibalsan and Kharkhorin. The geographic scope of the project is shown in Figure 1. Overall, 392 herder groups (representing approximately 1300 households) participated in the project. Of these, 234 groups (representing 978 households) are located in the Phase I Areas.[12] These groups signed the leases for their peri-urban rangeland tracts with their respective soum governments, and participated in PURP training programs between 2010 and 2013.A timeline for Phase I of the project is provided in Table 1.

[12] Including 34 Intensive and 200 Semi-intensive groups.

Figure 1. Geographical Scope of the Peri-Urban Rangeland Project



Note: Phase I areas (Ulaanbaatar, Darkhan, Erdenet) are in Green. Phase II areas (Kharkhorin and Choibalsan) are in Red.

Table 1. Phase I Project Activity Timeline

Activities	Start	End
Herder Group Application and Selection	Oct-09	Sep-10
Lease signed-237 Herder Groups signed leases[1]	Sep-10	Mar-11
PURLS – Baseline	Sep-10	Jan-11
Well Installation	Apr-11	June-13
Herder Group Training	May-11	July-13
Supplying Materials for Shelter and Fence Construction	Dec-11	Mar-12
Supplying Seeds for Plantation	Feb-12	Jun-12
PURLS – Follow-up #1[2]	Dec-12	Apr-13
End of compact	Sep-13	-
PURLS – Follow-up #2 (planned)	Dec-16	Feb-17

[1] 237 HGs signed leases but 234 remained at time of follow-up.

[2] PURLS Follow-up #1 occurred while well installation and training activities were still ongoing

In this report, we compare characteristics of project beneficiary households to comparison households in order to draw conclusions about the effects of the project. It should be noted that because of the long term nature of many of the outcomes under investigation, and due to the early timing of the Phase I Follow-up Survey, which was fielded during the project implementation, it may be too early to detect effects of the project on some key outcomes. Nonetheless, the current analysis still provides valuable information on short-run impacts of the project. In addition, the data collected for this project provides a rich source of information on the households and herder groups that participated in the project. Since the information will be publicly available, an important component of this report is to describe these data so that they might be used in other research or planning activities. The main project outcomes that the evaluation expects to find are split up into short and long-term.

iii. Expected Short-Term Outcomes

- Increase tenure security
- Change in stocking rates and improved grazing practices to maintain carrying capacity of land
- Improved herd composition, particularly an increase in foreign breed and crossbreed milking cows
- Increase in hay production, hay storage, and use of hay and other prepared fodder

iv. Expected Long-Term Outcomes

- Higher livestock productivity
- Decreased herd mortality
- Increased income from livestock
- Improved pasture quality due to reduction in overgrazing

A complete overview of the PURP logic framework can be found in Section III, which shows how project activities will affect the desired short and long-term outcomes.

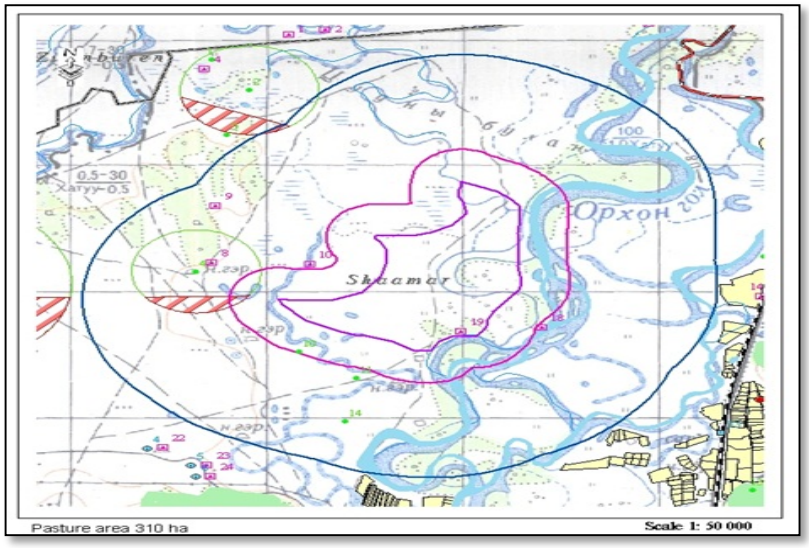
B. Selection Process in Phase I Areas

The selection process in PURP Phase I areas began in March of 2009 when the PURP Project Implementation Unit (PIU) hired a local contractor to investigate, identify, and map potential rangeland tracts in the project areas – with the project areas being defined as any land within approximately 30 km radius of Mongolia's three main urban centers, Ulaanbaatar, Darkhan and Erdenet. The local contracting firm hired for this task was the Centre for Policy Research (CPR). Information regarding the characteristics of rangeland and herder households was gathered in these areas. Moreover, the PIU identified 988,333.6 hectares (ha) of land that were suitable for leasing. The primary criteria included access to well water within an average depth of 50 meters of the

surface, regular usage by local herders, and sufficient pasture and forage area to support herder project activities.

Tracts of land deemed to have met these criteria were mapped using geographic information system (GIS) software, including the location of important resources. Figure 2 is an example of an individual tract. The inner pink line denotes the land tract being leased with exclusive use rights. The outer pink line is a 500 meter buffer zone surrounding the tract and the outer blue line represent a 2 kilometer buffer zone surrounding the tract. The buffer zones were included in the map to highlight potential resources, camps, and population that may be affected by the lease.

Figure 2. Example of Land Tract Map



Shortly after land tracts were identified, MCA-M began outreach activities. The PIU held a series of workshops with local government officials and herder families in order to disseminate information about the project and encourage participation, Herder households were provided with instructions on how to apply for project assistance. They were encouraged to form herder groups and submit applications. The PIU worked with the groups to help them map the boundaries of their rangeland tracts and prepare other documents needed to apply to participate in the project. The PIU received a total of 677 herder group applications. At the same time, local soum officials were encouraged to form selection committees comprising both local officials and citizens. These committees would be responsible for reviewing and scoring all applications submitted by herder groups within their soum.

The deadline for herder group applications was October 15, 2009. Six hundred and seventy-seven herder groups applied for leases and project assistance. Of these, 467 were given passing scores by the soum selection committees and short-listed for project assistance.

Herder groups applying for project assistance were required to apply as “intensive” or “semi-intensive” and the scoring of these applications differed, with applications from intensive groups having less emphasis on animal husbandry (in particular for non-dairy breed cattle) and socioeconomic criteria, and more emphasis on experience and success with foreign breed milking cattle, use of animal shelters, and fodder preparation. Intensive groups were able to apply for smaller areas of land under the presumption that these types of dairy operations were less reliant

on pastureland to feed their animals. Tables 2 and 3, below, provide a detailed description of project requirements and selection criteria. The criteria listed in Table 2 were strict cut-offs. A herder group that did not meet the requirements listed in Table 2 was not eligible to participate in the project. Table 3 includes a set of softer, continuous criteria on which the herder groups were measured. The exact scoring criteria, with weights given for specific items, was different for Intensive and Semi-intensive herder groups and is included in Appendix A.

Table 2. Minimum Criteria for Short-Listing Phase I Herder Groups

1.	A herder group comprises 2-7 herder households
2.	Herder household members must be registered in the specified region, or used pastures for more than 180 days in the specified region
3.	Must have consensually agreed to balance number of livestock with pastureland carrying capacity (contract condition)
4.	No household shall own more than 1000 sheep units[13]
5.	Members of the herder group must be Mongolian citizens
6.	Each household must derive a minimum of 60% of its income from herding
7.	Herder group must provide a guarantee for the health of their livestock

Table 3. Criteria for Scoring Short-Listed Herder Groups

Socio-economic criteria
Good and exemplary history and ability of cooperation
Collaborative supply of livestock products (milk, meat, hides, cashmere, etc.) to the market
Majority of household members collaboratively utilize the same pasture
Herder group has had a leader for a minimum of 1 year
The leader of the herder group has been living on pastureland site of group
At least two-thirds of the households in the herder group have been the same for last 3 years
Sustainable livestock management capability
Amount of herder income that originates from animal husbandry
Majority of households in a group have more than 3 years of experience managing livestock operations of dairy cows, multi-purpose (dairy/meat) cattle or meat livestock of high yields
All households in a group have experience in meat or milk livestock herding/handling
Number of low-income or female-headed households
Percentage of herder households in a group who are low-income or female-headed
Percentage of adult members of the group registered as residents of the specified region
Current farming situation
Livestock genetic quality
Number of herder households who own genetically improved livestock (meat or dairy)
Average annual milk yield of pure and cross breed dairy cows of herder group
Experience of milk and meat supply to the nearby market
Household experience of milk supply to nearby markets during the winter and spring for last 3 years
Household experience of meat supply to nearby markets during the whole year for last 3 years
Fodder preparation
Majority of households have been able to feed livestock (dairy, multi-purpose and meat animals) for the last three years with concentrate feed, silage and stored hay/forage.
Herder group has at least one shelter for livestock
Herder group owns hay making and fodder preparation machinery or equipment
Herder group owns a milk processing equipment

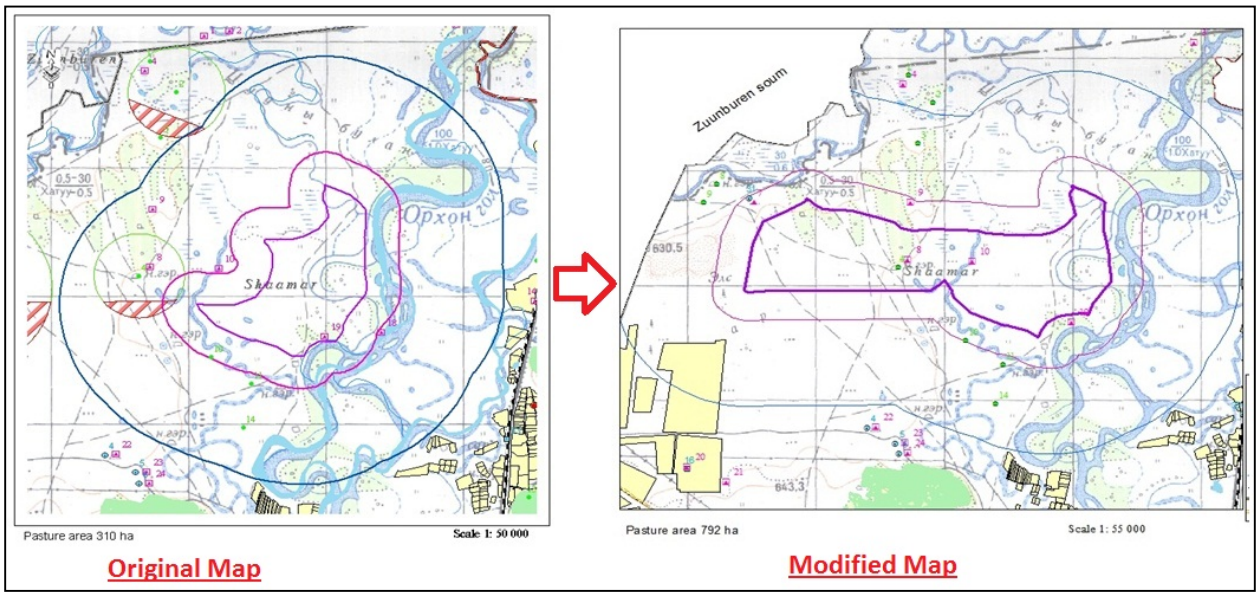
[13] A "sheep unit" is a generic way of measuring "number of livestock" that takes account of the differing size of animals. Goat = 0.9, Sheep = 1, Camel = 5.7, Cattle = 6, Horse = 6.6

Since only 300 tracts within the project were available, the original project plan called for selecting beneficiaries from the pool of short-listed applicants through the development of a business proposal. The herder group that submitted the top ranked business plan proposal in each soum would have been granted automatic entry into the project while the rest of the short-listed herder groups would have moved on to participate in a public lottery process. The lotteries would be organized on a soum-by-soum basis, which would have randomly allocated the remaining leases among the qualified applicants. However, the lottery and business proposal process was not pursued, as there were not enough qualified groups, following a MCA-M and MCC quality check.

MCA-M and MCC carried out a review of the 467 short-listed herder groups, which led to the disqualification of many herder groups due to herder group land tracts not meeting project requirements. The issues largely regarded required land tract size, water access, maintaining proper buffers from water and roads, non-inclusion of protected areas, and especially overlap with neighbor use rights[14]. Many tracts of land were resized to meet project requirements; however, some plots were unable to be included, which decreased the number of eligible herder groups to 284. For neighbor use rights, MCA-M and MCC carried out an extensive field verification process in summer of 2010 to ensure compliance with World Bank's Operational Policy on Involuntary Resettlement (O.P. 4.12), Each short-listed herder group's land tract was examined for potential involuntary resettlement issues. Every effort was made to restructure the boundaries of short-listed land tracts so that involuntary resettlement would be minimized and non-applicant herder households would not be forced off the land they normally utilized. See Figure 3 below for an example of a track modification designed to exclude camps of neighboring households and natural resources such as rivers and wells.

[14] Some herder households residing near land tracts claimed by the short-listed herder groups objected to the leases, noting their animals grazed that same tract of land, and they had not been made aware of the project or its goals of granting exclusive use rights over common use rangeland.

Figure 3. Example of Modified Land Tract Boundary



The original map incorporates fertile lands on the riverfront that are claimed by multiple groups. The second map excludes these disputed riverfront areas and embraces a larger area of less fertile inland rangeland. The inner pink line represents the lease tract; the outer pink line is a 500m buffer and the outer blue line is a 2 km buffer

Of these 284 remaining groups, 47 herder groups had to be excluded because several governors of districts in the city of Ulaanbaatar – which includes pasture land within its borders – withdrew their districts from the project. Since the number of available tracts in the program exceeded the number of qualified applicants, the business proposal selection and lottery were abandoned and all 237 groups were offered lease contracts and project assistance. Between the baseline and follow-up survey, three herder groups dropped out, leaving 234 herder groups remaining in the project.

C. Evaluation Design

As described in the PURP Phase I baseline report[15], there were significant differences before project implementation between households that were selected to participate in the project and those that were not. Originally, it was intended that a random subset of applicant groups would be selected to participate in the project. The random nature of the selection process would have ensured that among the applicants, those chosen to receive the project would have in expectation been identical, on average, to those that did not. However, since this plan was not feasible in practice, the differences observed between project recipients and the other groups in the baseline survey complicate the interpretation of any post-program differences between the project

[15]"Peri-Urban Rangeland Project (PURP) Baseline Report for Phase I Areas." Innovations for Poverty Action Report to the Millennium Challenge Corporation, (2012).

recipients and the other groups. Post-program differences might be the result of the project, but they might also be the result of the baseline differences—observed or unobserved—between the groups of households. As we outline in the PURP Phase I design document[16], the solution we employ is one in which we match project households with non-project households that are as similar as possible on a large range of characteristics. Such a design is not ideal, but in consultation with MCC, it was decided that such a design was the best and most rigorous option feasible given the implemented selection process.

A matching design attempts to determine the causal effects of an intervention by simulating the logic underlying a randomized controlled trial. A randomized controlled trial would create two similar groups of households by randomly allocating the project to some herder groups and not to others. The matching strategy works in reverse. One starts with households already chosen to receive the project and then identifies other households that are similar to project households, to serve as a comparison group. By matching the selected households on characteristics observed in the data, it is possible to create a comparison group for the project households that are similar along the dimensions observed in the survey. We then use these "matched" households in our analysis of project effects. Households that are particularly poor matches—that is, non-project households that are very different from project households—are not included in the analysis. This decreases the chance that we will incorrectly attribute post-program differences to the project.

The methodology is designed to create two research groups that are similar along the variables used for the matching process, but the challenge is the characteristics that are not measured in the survey may differ between groups. The current evaluation methodology matches households that applied for and received land leases from the project to other households that did not participate in the project. However, there was some reason that one group applied and the other did not, even among households with otherwise similar characteristics. The underlying cause could be quasi-random factors such as a random power outage that prevented some households from listening to the radio at the time the project was advertised. Differences of this kind are a nuisance but not something that affect the quality of data particularly.

In contrast, the underlying cause could also be that applicant households exert significantly more effort in general to be informed than households that did not apply. Since that underlying desire for new information is difficult to measure, it cannot be used in the matching process. This is only one example of an unobserved characteristic that can confound attempts to attribute effects to the project. The problem here is that these underlying, unobserved differences might be systematically related to outcomes that we wish study in the project. For example, the underlying difference in motivation and ambition might mean that project households are more productive over time than non-applicant households. It could be that project households are more likely to seek out new and better herding techniques or business opportunities, regardless of the existence of the PURP. As a result, any observed differences in the follow-up surveys might be due to the project or they could be due to these unobserved differences. Another possibility is that there are differences in land quality and water access among the project and comparison groups, and the difference affected both eligibility for the project and the potential outcomes for those who were not eligible.

[16] "Peri-Urban Rangeland Project (PURP) Impact Evaluation Design" Innovations for Poverty Action Report to the Millennium Challenge Corporation, (2012).

In order to find the best matches—that is, those project and non-project households that are most similar—we first use what is called logistic regression to estimate the propensity that a household is in the project. The propensity score is simply a summary of the chances that a household is in the project, given that household's various characteristics. The PURLS measures a great deal of information about households, such as their income, household size, economic activities, herding practices, migration and so on. We use all of this information to obtain an estimate of the chances that any particular household is in the project. Some households will be very likely to be in the project, some households will be less likely to be in the project. A complete list of the variables used for estimation of the probability of project participation is included in Appendix B.

The next step in the process is to use this summary measure—the propensity score—to create matches of project and non-project households. We want to match project and non-project households that are as similar as possible in their propensity score. The statistical technique we use to achieve this, attempts to minimize the "distance" between households on their propensity score. We carry out what is referred to as "full matching"—that is, we allow project households to be matched to multiple non-project households and we also allow non-project households to be matched with multiple project households.[17] Once this is done, we have sets of matched households. In carrying out our analysis of project effects, we compare within these sets. That is, we compare the outcome of interest, say, milk yields, between project and non-project households in each of the matched sets. In this way we reduce the problems described above and increase our ability to attribute any eventual differences to the project.

We used the *optmatch*[18] and *RItools*[19] packages for the statistical environment *R*[20] to carry out matching. Figure 4 reports the result of a balance test carried out on the data before and after matching. If the data are "balanced" it means that they resemble what we would expect from a randomized controlled trial (RCT)—that observations are the same, on average, aside from being in the project or not being in the project. Each solid dot represents the unadjusted balance on a variable before matching. Hollow squares represent the balance on variables after full matching. If the data are balanced, the point will be closer to the middle zero line on the graph. As can be seen in the figure, the data are much better balanced after the full matching has been performed. Thus, we are on stronger ground in terms of attributing effects to the project when doing analysis using the matched data because we are more confident that underlying, pre-project differences have been minimized.

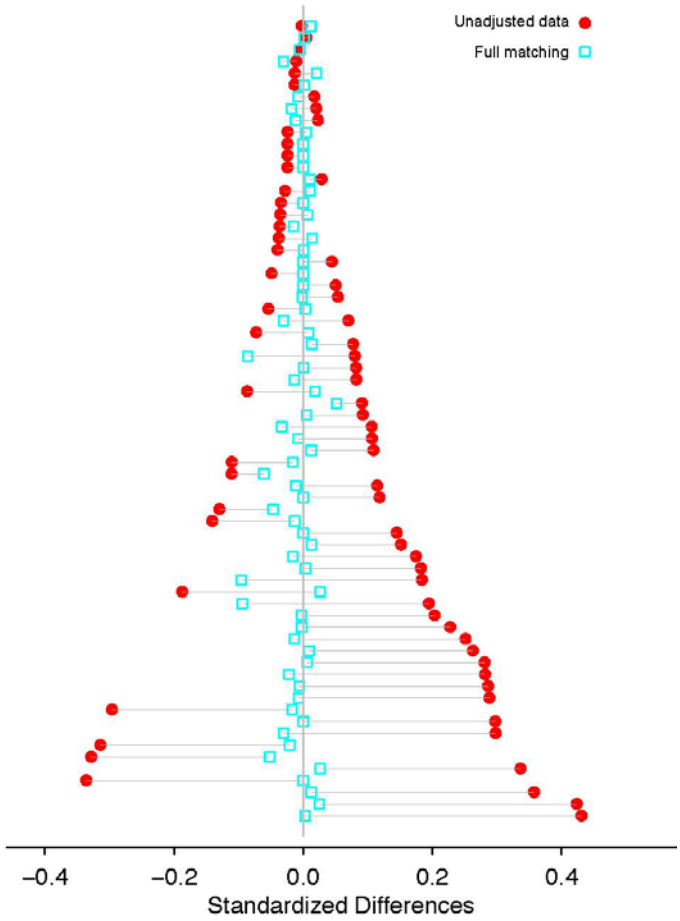
[17] For a discussion of matching methods, see Chapter 8, "Basic Tools of Multivariate Matching", in Paul R. Rosenbaum (2002). *Observational Studies*, New York: Springer.

[18] Hansen, Ben and Fredrickson, Mark. "Optmatch: Functions for optimal matching." R package version 0.8-1. (2013). See also, Hansen, Ben and Klopfer, S.O. "Optimal full matching and related designs via network flows." Journal of Computational and Graphical Statistics, 15, 609—27. (2006).

[19] Bowers, Jake, Fredrickson, Mark, and Hansen, Ben. "RItools: Randomization Inference Tools." R package version 0.1-11. (2010). See also, Hansen, Ben and Bowers, Jake. "Covariate balance in simple stratified and clustered comparative studies." Statistical Science. 23(2):219—36. (2008).

[20] R Core Team. "R: A language and environment for statistical computing." R Foundation for Statistical Computing, Vienna, Austria. (2013), http://www.R-project.org/.

Figure 4. Balance Tests



II. Data Collection

A. Contracting

The MCA-M M&E unit hired two firms, MEC and the Mongolian Center for Development Studies (MCDS), to conduct the data collection for PURLS Phase I Follow-up. These firms were responsible for finalizing the questionnaire in consultation with IPA and MCA-M, translation of the questionnaire into Mongolian and back-translation into English, interviewer training, data collection, filing and organization of collected surveys, documentation of the data set, data entry, data cleaning, and delivery of a cleaned, well organized data set. MEC and MCDS were ideal candidates because they had previous experience with the PURLS baseline data collection as well as other data collection operations that worked with similar surveys. The firms also possessed strong data management skills and were capable of entering and processing large amounts of data in a limited time period.

B. Questionnaire Design and Description

Three data collection instruments were developed for PURLS Phase I baseline survey – the household questionnaire, the herder group questionnaire, and the soum governor questionnaire. The household questionnaire consisted of 19 modules and required approximately 77 minutes to complete, on average. The herder group questionnaire and the soum governor questionnaire required approximately 24 and 100 minutes to complete, respectively. The follow-up survey questionnaires were designed in fall and winter of 2012. The follow-up questionnaires used the baseline questionnaires as a model, but some changes and additions were required to resolve issues faced during baseline and to account for intervening project activities. The follow-up household questionnaire consisted of 18 modules, and took an average of 49 minutes to complete. The herder group leader questionnaire took 13 minutes, and the soum governor questionnaire took 64 minutes, on average.

Piloting of questionnaires was conducted to ensure the internal consistency and clarity of the instruments being used before implementation. These activities focused primarily on new sections and updated questions. The draft survey was administered to a small number of herder households (roughly 20) living outside the project areas in order to assess whether any of the questions were confusing, problematic, or inconsistent. Any problems that were encountered during this focus-group/ pretesting phase were carefully recorded in a report. These focus groups and piloting exercises took place from November to December of 2012.

After piloting, the data collection instruments used for the baseline were updated and modified for the follow-up data collection in the Phase I areas. The main changes to the Household Survey included simplifying the expenditure section, expanding the sections on yearly fodder usage and calving cycle to better capture expected seasonal project effects, reducing the number of questions about planned investment, reducing the sections on camp infrastructure, adding a new section for project households about project activities and their perceived benefits, and generally improving survey language and structure for clarity. For the Herder Group Leader Survey, questions were added about changes in group membership since the beginning of the project, about difficulties faced in transitioning to a new type of herding, and about the lease area and project assistance received. New sections were added on joint business activities within the group, and about the reasons that a group dropped out of the project. The Soum Governor Survey did not change substantially from the baseline.

The three questionnaires can be found in the Appendix and details on the content of each questionnaire are provided in Table 4 below.

Table 4. PURLS Survey Questionnaires – Types and Content

Household Survey	Herder Group Leader Survey	Soum Governor Survey
• Household expenditure and income • Loans, support and assistance received • Migration patterns • Infrastructure & pastureland quality at seasonal camps • Household livestock information • Livestock hay-making and forage production and purchases • Land disputes • Future investments • MCA-M Peri-Urban project activities and opinions	• Basic herder group information • Information on herder group members • Details on transition to intensive or semi-intensive herding • Lease area information • Herder group joint business activities	• Demography and migration in Soum • Services available • Soum-wide livestock and land information • Land disputes • Donor programs and development projects

C. Sampling Strategy & Response Rates[21]

i. Baseline

Because participation in PURP was not randomized in the Phase I areas, there was no natural comparison to the PURP groups at the herder-group level. Because of this, it was decided to conduct the impact evaluation at the household level, by comparing households in the project with others not in the project, as detailed in Section I.C. Prior to fielding of the PURLS Phase I baseline survey, three potential comparison groups were identified:

1. *Applicant Households:* Households that applied for the program but were not accepted – either because they were not short-listed or because they were unable to modify their application in order to comply with the resettlement policy.
2. *Neighbor Households:* Households that had a winter camp within two kilometers of the boundary of a lease area for which an application was submitted, but who did not themselves apply to the project.
3. *Representative Households:* Randomly sampled households residing in the soums which participated in the project, but who did not themselves apply to the project, and did not have a winter camp within two kilometers of a lease area boundary.

These categories then served as the basis for choosing the sample of the Peri-Urban Rangeland Leasing Survey (PURLS). Overall 3,273 households were interviewed for the baseline survey, which was conducted from September 2010 to January 2011. These were sampled from four lists, as follows:

[21] Additional breakdowns of response rates, and information on which household members participated in the interview, can be found in Section V.C. below.

1. *Potential Project Beneficiaries:* All households that were members of a list of 317 potential project herder groups, which was provided to IPA by PURP at the beginning of the baseline survey (August, 2010). In total 1,172 households were targeted, after removing duplicates.[22]
2. *Rejected Project Applicants:* All households that were members of a list of 169 groups that had applied and been rejected from the project by the beginning of the baseline survey.[23] In total 589 households were targeted, after removing duplicates.
3. *Neighbor Households:* Households with a winter camp within two kilometers of a potential PURP lease area boundary. This list was provided by PURP's contractor CPR. Only 287 of the 317 potential PURP groups had neighbor lists associated with them. For each of these, one neighbor was randomly sampled, for a total target of 287. If a neighbor could not be located, a replacement neighbor could be used (up to 5 replacements were sampled).[24]
4. *Random Sample:* Households randomly sampled from a list of all herder households residing in soums participating in the project, produced by PURP's contractor CPR after extensive reconnaissance work. In total 1,700 households were targeted in order to achieve sufficient statistical power for impact analysis. Samples were proportional to the number of potential PURP herder groups in the soum. After an initial sample was drawn, two replacement lists were drawn from the remaining households in order to achieve the desired number of interviews.

Table 5 shows the details of the survey response rates for the baseline household survey. The "Targeted Number" column shows the number of plots that were originally sampled from the data, after removing duplicate households. The other columns give the number of households with each survey status. The completion rate was highest for the random sample (97 percent), due to the extensive list of replacement households that was available for that group. Potential project beneficiaries also completed the survey at a high rate of 84 percent. Rejected project applicants had a very low response rate, partly because of survey refusal (about seven percent) but primarily because many of these households were found not to live in the soum in which they applied for a land lease through PURP. This may have been the reason for their rejection from the project – all PURP group members were required to reside in the soum of their lease area. Completion rate for neighbor households is listed as the percentage of potential project groups with at least one neighbor interview, and was fairly low at 76 percent, mainly due to the small number of neighbors of many groups. Since neither the rejected applicant households nor the neighbor households were ultimately used as a separate comparison group but instead grouped with other non-project

[22] Potential project beneficiaries were not distinguished from the ultimate project beneficiaries until after the baseline survey was complete. Thus for sampling purposes, all potential beneficiaries should be treated as a single group.

[23] In addition to these 169 groups, another 191 had been rejected earlier in the application process, but PURP did not retain sufficient documentation about these groups and thus they could not be reliably identified for PURLS. Thus the "applicant group" is incomplete.

[24] Part way through the survey, in November, 2010, it was decided to expand the neighbor sample, and up to three neighbors interviews were attempted per group.

households for the impact analysis, this higher non-response for these groups should not bias the results of the impact analysis.

Table 5. PURLS Baseline Household Survey – Response Number by Respondent Type

	Targeted	Completed	Refused	Not living in soum	Impossible	Percent Complete
Potential Project Beneficiaries	1141	957	35	132	17	84%
Rejected Project Applicants	589	345	40	193	11	59%
Neighbor Households[1,2]	287	217				76%
Random Sample[2]	1700	1646				97%

[1] Neighbor household completion rate is given as the number of groups with at least one complete neighbor interview. Some groups had more than one completed neighbor interview, bringing the total number of completed neighbor surveys to 325.
[2] Since neighbors and the representative random sample of households were sampled using a replacement rule, only the number of completed interviews, and not refused, impossible, or non-attempts, are reported.

For the herder group leader portion of the PURLS baseline data collection, the research team attempted to interview the leaders of all 317 herder groups that remained in the potential beneficiary group, and successfully completed 296 interviews (93 percent). A list of these leaders was provided by the PIU. For the soum governor portion of the PURLS baseline data collection the research team interviewed the governors of all 41 soums where the project was being implemented as well as the governors of an additional 31 non-project soums. Non-project soums were included to provide insight into how soum level dynamics differed in areas where the project was not being implemented.

ii. Follow-up

A different sampling strategy was chosen for the follow-up data collection, based on the data collected in the baseline survey. None of the three potential comparison groups was considered to provide a close enough comparison to the project households to enable a rigorous estimate of project impacts. Instead, statistical matching was conducted to find the specific non-project households, from any of the potential comparison groups, which had the greatest degree of similarity with treatment households across a broad spectrum of household traits. As a result, the sample of households for the follow-up survey was broken up into two separate groups that are defined as follows:

1. *Project Households:* All households that were part of the 234 selected herder groups.
2. *Comparison Households:* All non-project households were grouped together as one "comparison" group and then matched to project households based on propensity score, as described in Section I.C. Since the evaluation design only uses comparison households that match closely with project households, there was an over-supply of low-probability

comparison households in the baseline sample. Because of this, a "low-priority" list was created containing households that were poor matches to any project households, and more lenient response rate requirements were imposed during the Follow-up Survey for households on this list.

In addition, both the leaders of individual herder groups as well as the governors of the soums in which the project tracts are located were surveyed to provide additional information on lease areas, joint group activities, and soum characteristics.

Data collection was undertaken by MEC and MCDS starting in December of 2012 and was completed in April 2013, with the bulk of data collection completed by the end of February. As with the baseline data collection in the Phase I areas, rough terrain and the high mobility of herder household conspired to prevent the data collection team from interviewing every single household targeted in the sample. However, drawing on lessons learned from the Phase I baseline data collection, the survey team created an interview protocol to better improve their chances of finding the respondent. In the event that the respondent was not home, they would conduct two additional attempts at different times during the day (morning, afternoon, evening) and spread out over at least a two week period with a minimum of three days between visits. They also checked with soum authorities to confirm that a particular household was in fact residing in that soum. To encourage participation, households were also incentivized between 2,500 and 3,000 tugriks in mobile phone credits. All these activities made it possible for MEC and MCDS to locate and ultimately interview a high proportion of the targeted households.

Household members were considered eligible respondents if they were over 18 and had knowledge of the household finances and livestock herding. The interviewers interviewed whichever knowledgeable household member was available when the interviewer visited the household. The household head took part in the interview in 77 percent, and was the main respondent in 65 percent of cases. [25] In over 90 percent of cases where the household head was not the main respondent, their spouse was the main respondent. In 95 percent of interviews, the interviewer reported that there were no disagreements between household members on any of the questions answered. Additional analysis including the gender of survey respondents is conducted in Section V.C. below.

Table 6 present the response rates for the follow-up survey. The first column gives the targeted number of households in three categories: project, high-priority non-project, and low-priority non-project. The project target was complicated by the fact that the baseline survey was conducted prior to the final determination of which groups would enter the project.[26] The baseline survey sampled from a list of potential project beneficiaries, but it was not until the follow-up survey when it could be confirmed which households actually ended up in the project. However, the PURP did keep a separate list of households that were in the project. IPA took this list and matched it with the baseline household list from PURLS, based on names of household members, locations, etc. This process produced a list of 700 unique project households, of which 611 had been

[25] In Mongolia, when a married couple leads a household, the husband is automatically considered the head.

[26] Most project groups signed leases in January to March of 2011, while the PURLS baseline survey was completed in January 2011.

interviewed in the PURLS baseline, while the others were only on PURP's list. All 700 of these households were targeted for the follow-up survey. The non-project targets were broken down into high and low priority households depending on their "propensity score" which was estimated from the baseline data. The propensity score is the probability that a household in the sample was in the project, based on observable characteristics such as income, number of animals owned, location, and numerous others variables collected in the baseline survey. Details are given in Section I.C. The estimate of project impact uses information only from non-project households that have a very similar propensity score to a project household. Those households that were better matches were labeled high priority during data collection, meaning the survey team was instructed to put more of an effort to obtain data from the high priority households and given more leniencies on the low priority households, which did not closely resemble any project households.[27]

Overall response rates were high, 86 percent for high-priority non-project, and 89 percent for project households. The rate for low-priority non-project households was lower because less effort was expended to find and interview these households.

The third column of Table 6 gives the number of households in each category that were verified to actually be in the project at the time of the follow-up survey. It is notable that some of these households (those in the high-priority list) were not listed as potential project beneficiaries for the baseline survey, although the reasons behind this are not clear. In addition to those households listed in Table 6, MEC and MCDS identified and interviewed 19 households which were discovered to be PURP participants during the field work, but did not appear in either the PURLS baseline survey or in the PURP database, leading to a total of 704 project households with complete follow-up interviews. Overall 2759 households completed interviews for both the baseline and follow-up surveys, of which 621 were in the project and 2138 were not in the project.

Table 6. PURLS Follow-up Household Survey – Response Number by Respondent Type

	Targeted	Completed	Verified to be in Project[1]	Refused	Impossible	Not attempted	Percent Complete
Project	700	620[2]	592	9	71	0	89%
High priority	2075	1775	93	104	196	0	86%
Low priority	587	431	0	26	19	111	73%
Total	3362	2826	685	139	286	111	84%

[1] The households verified to be in the project are a subset of those with completed interviews.
[2] Of the completed interviews in the Project category, 553 also had complete baseline interviews.

[27] Both high and low priority households were used in the analysis presented in Section VI. There is no harm done by keeping the low-priority households, since they will be automatically dropped from the analysis if there are no good matches. On the other hand, the propensity-score model was modified between the time that the priority list was created and the time that the analysis was completed, to better reflect the actual selection process of the project. With the new model, some of the "low priority" households may now be good matches with project households.

For the follow-up of the herder group leader survey, all 234 project group leaders were targeted, regardless of their interview status in the baseline survey.[28] Response rate for group leaders was higher than for project households. In total, 217 (93 percent) of the group leaders were successfully interviewed. All 72 targeted soum governors, or knowledgeable members of their staff, were successfully interviewed.

D. Data Quality Monitoring

IPA conducted independent data quality monitoring (DQM) for the PURLS follow-up survey. This is in addition to the internal DQM conducted by MEC and MCDS, which involves review of each questionnaire by a team leader at the end of the day for completeness and logical consistency. There were two main purposes for DQM activities. The first purpose was to check whether the data collection activities in the field properly took place. IPA DQM staff conducted field monitoring to check whether MEC and MCDS properly administered the PURLS and that none of the data was falsified. This was accomplished in two steps: first, by having IPA DQM staff sit in with each enumerator for two interviews. During the first interview, the DQM staff filled out a copy of the same questionnaire that the enumerator was filling out. They noted any problems with the enumerators' asking or recording method, and after the interview was completed, they compared the two versions of the questionnaire. The DQM staff then met with the survey team leaders and discussed specific problems that enumerators were having. Team leaders then worked with their enumerators to address any problems. After this initial round, the enumerators were followed for one more interview to ensure that the previously identified problems had been fixed and no new problems arose. After the field accompanying process, IPA DQM staff began the second step of the survey quality control process, which involved the review of a randomly selected sample of audio recording of interviews against the hardcopy of the corresponding survey. For this second review step, enumerators who had performed poorly in the field accompanying were focused on to ensure that all enumerators were performing at an adequate level. Any problems identified were provided in a report to MEC and MCDS and surveys were either modified based on the audio recording, or some sections of the survey were required to be re-collected.

The second main purpose of the DQM activities was to ensure that the dataset collected was accurate and corresponded to the hardcopies of the PURLS collected. This was done through manual checks, or the process in which values in the dataset were checked to see if they matched those in the questionnaires. The manual check took a representative sample of all the variables in the PURLS dataset to ensure that the entire dataset was accurate. IPA followed a strict criterion to ensure that the error rate, or the number of mismatches between the hard copy questionnaires and entered values, did not exceed 0.5 percent. If any dataset's error rate exceeded this value, the data collection contractor had to re-enter the dataset for the given survey and another round of manual

[28] In addition, leaders of potential PURP groups who were interviewed for the baseline survey, but did not end up in the project, were also targeted for the follow-up survey, but the information obtained was minimal and of limited utility. These group leaders will be dropped from the sample list in future surveys, and will not be considered for the remainder of this report.

checks were conducted. This process was repeated until every dataset had an error rate below 0.5 percent.

Ultimately no serious problems arose during the data collection, and all quality standards were met by the contractor.

III. Comparison of Peri-Urban Areas Using Soum Governor Survey

The Soum Governor Survey collected information on numerous characteristics of project soums, including population trends, animal numbers, land use patterns, major land disputes, active development projects, and perceptions of PURP among local officials. For the current analysis, the results of this survey will be used to examine the extent of the PURP in the three Phase I project areas, as well as compare herders with average herders in these areas, to get a better understanding of where project beneficiaries fall on the socioeconomic spectrum. As shown in Figure 1, the project areas covered pastureland in a 30 kilometer radius around Darkhan, Erdenet, and Ulaanbaatar cities. Table 7 presents information on the three project areas. The largest project area in size was Ulaanbaatar, followed by Darkhan, and Erdenet which was half the size of Darkhan area. However, Darkhan had the largest number of groups, followed by Ulaanbaatar and Erdenet. Of the total project area, about 12 percent was covered by PURP leases in Erdenet area, 10 percent in Darkhan area, and five percent in Ulaanbaatar area. Although the project is relatively small in extent compared with the vast common use rangelands of Mongolia, it has directly affected a significant proportion of herders in all three areas, particularly in the Darkhan and Erdenet areas, and the leases have become a salient feature covering a substantial portion of pastureland surrounding the cities. The last two columns of Table 7 give the average number of livestock (in sheep units) owned by project beneficiary households in each area, and the average number of animals per household for all households in these areas. We see that in all three areas, project households have smaller average herd sizes. Since livestock are the main component of wealth for most herder households, it appears that project households were poorer than average, in all three peri-urban areas.

Table 7. Selected Statistics from Soum Governor Survey

Peri-urban Area	Number of PURP herder groups[1]	Number of soums	Total land area in project radius (hectares)	Percent of project area pastureland covered by PURP leases	Percent of herder households in area that are in PURP	Average animals per household in project areas[1]	Average animals per household, project households[2]
Darkhan	93	12	1,424,718	10.0	12.3	464	367
Ulaanbaatar	78	14	1,738,474	5.4	7.4	414	352
Erdenet	61	7	723,231	12.3	18.7	489	427

[1] Data on herder groups, including location, was not available for two of the groups, so this column sums to 232.
[2] Number of animals is reported in sheep units.

IV. Project Outputs and Opinions of the Project

As described in Section I, the PURP consisted of four major activities. Activities 2 – 4, Pastureland Leases, Provision of Infrastructure, and Provision of Training, can be viewed as the direct assistance portion of the project.[29] The direct assistance portion of Peri-Urban Rangeland Project had five key components:

1. Rangeland leases
2. Installation of wells
3. Provision of fencing and shelter materials
4. Provision of alfalfa seed
5. Training

This section presents the direct outputs of the project, and opinions and perceptions of each of these components gathered from project households through the PURLS survey. While all groups received leases, the other components of the project were not mandatory nor uniformly provided. The numbers in this section come from different sources, because the database that IPA received from PURP did not cover all activities up to the end of the compact, and occasionally was incomplete or contradicted the findings from PURLS survey. In particular, the PURLS Herder Group Leader Survey was used for numbers of groups that received alfalfa seeds and fence/ shelter materials, which were apparently not all captured in the PURP database. It was assumed that group leaders would be unlikely to report receiving materials from the project that they did not in fact receive. Note that since not all group leaders were interviewed, the numbers from PURLS may undershoot the actual number of groups that received assistance. For the number of groups that received wells, the PURP quarterly progress reports were consulted, as data from both PURLS and the PURP database were generated before all of the wells were drilled. Finally, the perceptions of the project came from the PURLS Household Survey.

Figure 5 presents the proportion of groups receiving each of the three material assistance components of the project. All eligible groups received wells, while the other materials were provided at the discretion of the group.[30, 31] Eighty-five percent of project herder groups received wells, and 83 percent received materials for fencing or shelters. About one third received alfalfa seeds.[32] Note that during the first year of planting, alfalfa seeds are not harvested, therefore,

[29] We do not report on the Legal Reform activity because it is not directly relevant to the impact evaluation, and as noted in Section I.A, no legal changes were made during the course of the project.

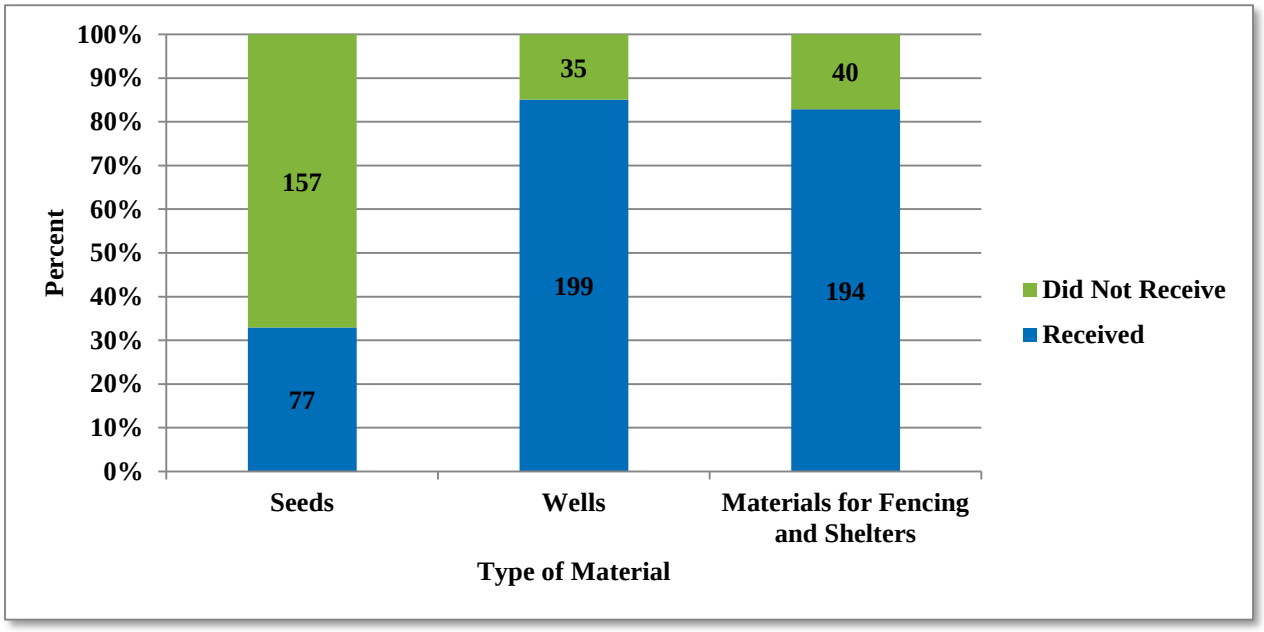
[30] On some lease areas, it proved impossible to find an appropriate place for drilling, so wells could not be provided to these groups.

[31] Wells, fencing and animal shelter material, and alfalfa seed were provided to herder groups with no upfront cost, but some repayment of the cost on a semi-annual basis will be required as part of the lease agreements. Up to 50% of the cost of the well installation is required, with a cap of 4.8 million MNT (a typical well installation cost 20-30 million MNT). The maximum amount of fencing or shelter materials provided by the project was three thousand USD, and the full amount of the fencing and shelter material must be repaid. One quarter of the cost of alfalfa seeds must be repaid.

[32] Herder groups who received permission to plant fodder on their leased land from their local governments were eligible to receive seeds to plant fodder.

although all herder groups who received the seeds had planted the alfalfa in 2012,[33] they would not receive harvest until the following year. Of the 77 groups that received alfalfa seed, there were a total of 59 households representing 32 groups that indicated in the household survey that they had an alfalfa field,[34] but only 17 of these, representing 12 groups, actually produced alfalfa in 2012. The one-year delay in harvest likely accounts for a large portion of the apparent low uptake at the time of the follow-up survey. No groups produced alfalfa without receiving seeds from the project, and only eight households produced alfalfa at the time of the baseline survey. It is also notable that only three non-project households interviewed in the follow-up survey indicated that they produced alfalfa in 2012. Uptake of the project assistance was also examined separately for male and female headed groups, and by groups considered "poor" (defined as having an average herd size per household of fewer than 200 sheep units, which was a definition often used by PURP implementers). The only notable differences were that female-headed groups were 10 percentage points less likely to receive a well (72 versus 82 percent) and poorer groups were ten percentage points more likely to receive alfalfa. Note the latter may be a spurious finding because intensive groups tended to have fewer animals and use more feed, but were not necessarily poor.

Figure 5. Herder Groups Receiving Materials



Of 16 total types of training available, on average 13 of these were attended by at least one member of each herder group.[35] Of those that participated in PURP trainings, 62 percent of the participants

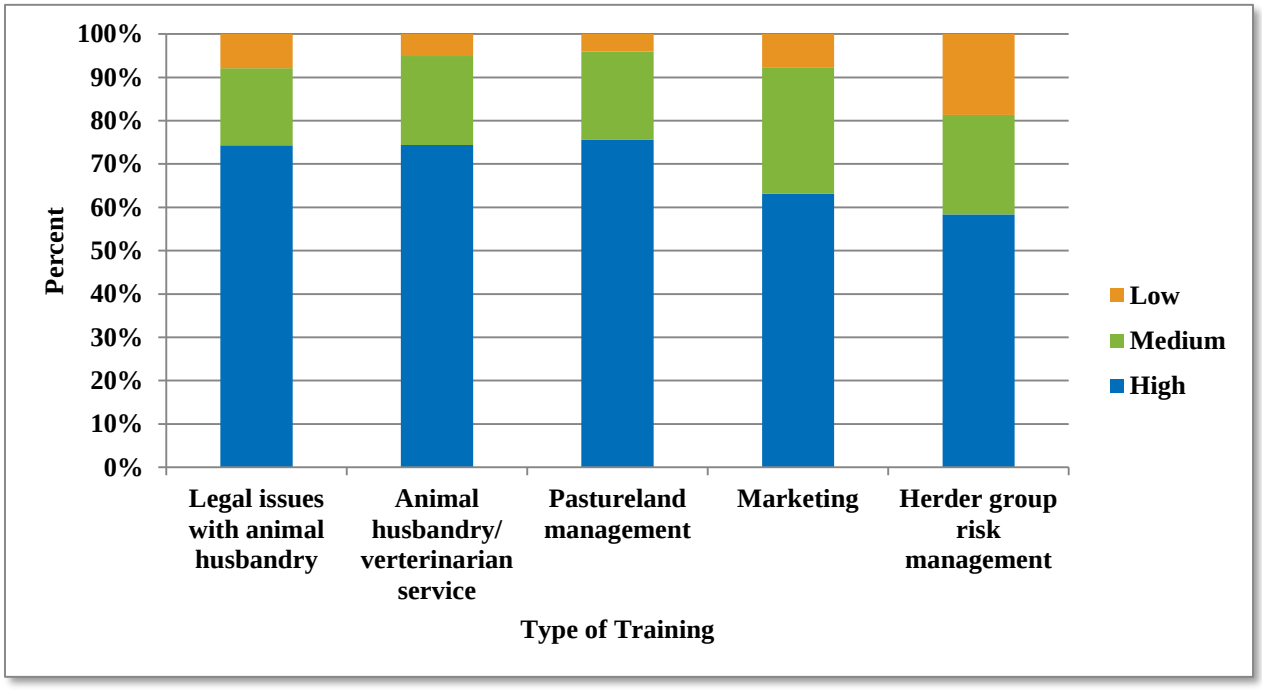
[33] As reported by PURP

[34] This may be a result of mis-interpretation of the question. If households planted alfalfa but would not receive their first harvest until the following year, it is possible that they would answer that they did not have an alfalfa field.

[35] This is based on data from CPR's quarterly progress reports to PURP.

were male while 38 percent were female. Figure 6 gives project households' perceptions of the usefulness of trainings on different subjects. More than half of project households considered training in all subjects as "highly useful," while only "risk management" was considered "low value" by more than 10 percent of respondents. The most useful trainings were those on pastureland management, animal husbandry and veterinary services, and legal issues in animal husbandry. The marketing and risk management trainings were somewhat less helpful to the average group, but still rated very highly overall.

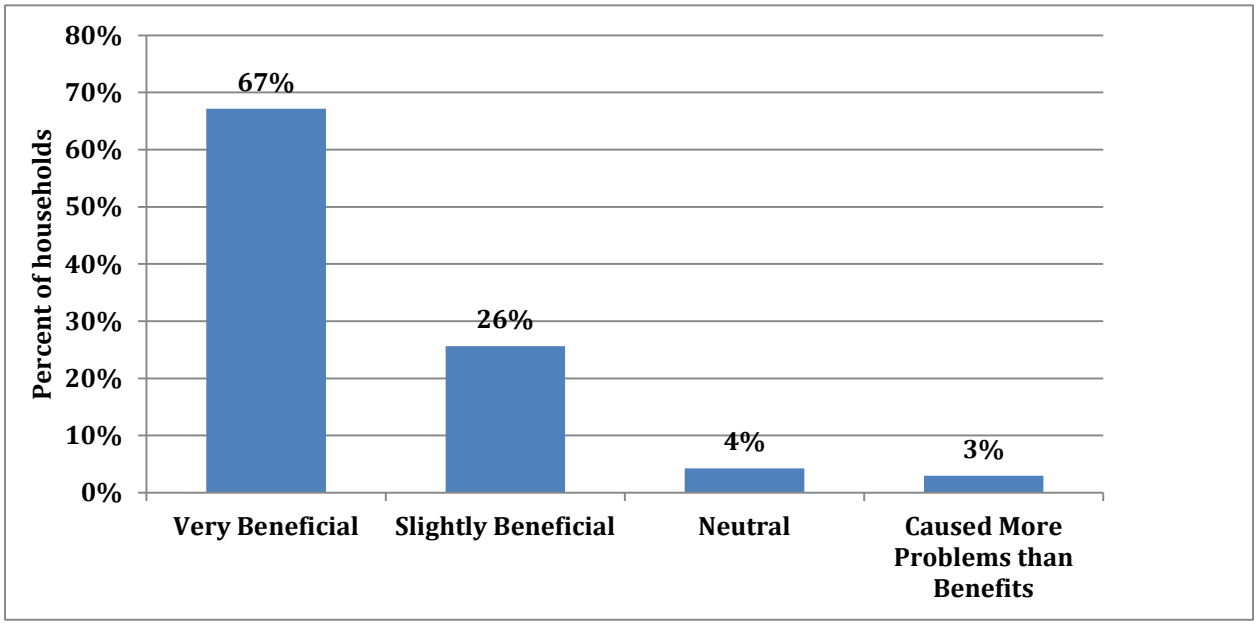
Figure 6. Project Households Perceptions of the Usefulness of PURP Trainings[1]



[1] Results are reported for those who gave an answer to the question. For all topics, approximately 15-20 percent of respondents did not attend the training, and approximately five percent "did not know" how useful the training was.

The vast majority (94%) of project households thought the rangeland leases were very beneficial or at least slightly beneficial. Only a small percentage felt that the leases caused more problems than benefits. Figure 7 presents the responses in more detail.

Figure 7. Project Households Perceptions of Rangeland Leases (%)



The PURLS also attempted to capture the relative importance of each project component, by asking respondents which areas in their lives improved as a result of the project. The largest number of project households (total 48 percent) felt that their access to water sources (via the provision of wells) had improved as a result of the project. The second most important benefit (named by 37 percent of project households) was the alleviation of pasture degradation, by preventing overgrazing through the award of exclusive land use rights. Significantly fewer project households (21 percent) felt that the project helped them to improve the quality and productivity of their livestock, or improve their ability to process and sell animal products, both of which were intended results of the training component of the project. Seventeen percent of households felt that they benefited from the provision of fencing and shelter materials. Only a few households (eight percent) felt there was an improvement in animal fodder and hay preparation, which is not surprising seeing how few households made use of the alfalfa seeds from the project. Using these results we can roughly classify the direct project assistance project components based on their importance to project households. The results are shown in Table 8.

Table 8. Ranked Importance of PURP Components

Rank	Project Component
Most important	Installation of wells
Second most important	Rangeland leases
Third most important	Training
Fourth most important	Provision of fencing and shelter materials
Least important	Provision of alfalfa seed

Overall, the participants in the PURP project found that the project was beneficial for them. In particular, the provision of subsidized wells was a very valuable contribution of the project, and most groups received the wells. The training and provision of fencing and shelter materials also had high take-up rates, while the alfalfa seed was not well received. Even in the short run, households found that the rangeland leases themselves were valuable, though this may prove more important in the future.

V. PURP Herder Group Characteristics

This section focuses on describing the herder groups that participated in Phase I of PURP. First we discuss Intensive and Semi-intensive herder groups, which are the broad categories into which all project groups were placed. Then we compare the differences between herder groups across areas. Finally we take a closer look at herder groups with female leaders and how they differ from those with male leaders.

A. Comparison of Intensive and Semi-intensive Herder Groups

We now turn to a comparison of herders that applied to the project as intensive groups versus those that are semi-intensive herder groups. The major differences between the types were described in Section I, and were primarily based on different application scoring criteria, which places more emphasis on experience and capacity with high-input dairy farming, lower reliance on pastureland to feed animals and thus smaller lease areas. It was also assumed that intensive herders would not typically engage in seasonal migration. The two types are described here in order to give an understanding as to the types and frequency of herder groups in the project, as a context for interpreting statistics about project households overall. The differences between the types of groups are quite distinct as will be described below. Because of this, we conducted separate impact analyses on intensive and semi-intensive herder groups. These separate analyses are presented in Section VI.C. However, because the small number of intensive groups means that statistical power is limited, for the main part of the impact analysis, presented in Section VI.B, the intensive and semi-intensive groups were grouped together. For the remainder of the report after this section, with the exception of Section VI.C, intensive and semi-intensive groups will not be analyzed separately.

Tables 9 and 10 show the number of intensive and semi-intensive herder groups, and the number of member households interviewed for PURLS, for all three project areas. Overall in PURP Phase I areas, there were 34 project groups classified as intensive, and 81 households in these groups have full baseline and follow-up data from PURLS. The frequency of intensive groups varied by area, comprising only 13 percent of groups in the Ulaanbaatar area, 14 percent in Darkhan area, and 18 percent in the Erdenet area. This difference in the balance of herder groups by area should be kept in mind when interpreting the combined impact analysis in Section VI.

Table 9. Number of Project Herder Groups in Phase I[1]

	Darkhan	Erdenet	Ulaanbaatar	All Areas
Intensive	13	11	10	34
Semi-intensive	80	50	68	198
Overall	93	61	78	232
Percent Intensive	14%	18%	13%	15%

[1] Data on herder groups, including intensive status, was only available for 232 of the 234 groups.

Table 10. Number of Project Households Interviewed for PURLS[1]

	Darkhan	Erdenet	Ulaanbaatar	All Areas
Intensive	32	27	22	81
Semi-intensive	258	124	158	540
Overall	290	151	180	621
Percent Intensive	11%	18%	12%	13%

[1] This only includes households that have data for both the baseline and follow-up surveys. Project status was determined by matching with the PURP database, as described in Section II.C.ii.

At the level of the herder group, we can look at the composition of the group members, and the characteristics of the lease area. In particular, we see in Table 11 that semi-intensive groups have slightly more members on average, and also have more than twice as large areas of land (780 ha) as intensive groups (360 ha) on average. The difference in area is not surprising, because of the lower land size requirements for Intensive groups based on the assumption of higher use of hay and fodder, and smaller herds.[36] Moreover, the number of households in the group was directly considered when determining land size requirements.

Table 11. Comparison of Group-level Characteristics, by Intensive and Semi-intensive

	Intensive	Semi-intensive	Overall
Number of households in group	2.97	3.45	3.38
Size of lease area (hectares)	362	779	719

When we look at outcomes from the Household Survey, we see major differences in the types of household that make up the groups, both at baseline and follow-up. These results are shown in Table 12. Nearly twice as many intensive than semi-intensive households were sedentary at baseline, and the difference widened by the time of the follow-up survey, where 29 percent of intensive and only 11 percent of semi-intensive households were sedentary. This suggests that the project influenced intensive, but not semi-intensive, herders to stop seasonal migration. Among households that did migrate, those in intensive groups were less mobile at both baseline and follow-up having both lower number of moves and average distance between camps. Semi-intensive herders that migrated increased their average number of seasonal migrations between baseline and

[36] A formula was developed based on the historical grass yield of the land, number of households in the group (as a proxy for number of animals), required area for hay and fodder fields (different for intensive and semi-intensive), and seasons of use (different for intensive and semi-intensive), which determined the minimum area of land necessary for each group to graze their animals entirely within their lease area in the specified seasons. Groups who applied for smaller areas of land and were unable to modify their map to include sufficient land, were disqualified from the project.

follow-up, while the average for intensive herders did not substantially change. Intensive households decreased their herd sizes between baseline and follow-up, while semi-intensive households increased their herd sizes. At the time of the follow-up survey, semi-intensive households had nearly 50 percent larger herd sizes, while they were only about 20 percent larger at baseline. While most households in both groups owned at least one milking cow (reflecting the high emphasis on milking cows in the application scoring for both types of group), intensive households were more likely to own improved breed milking cows, and these cows on average made up a larger fraction of their cattle. For both intensive and semi-intensive households, the likelihood of owning improved cows, and the fraction of those cows in the herd, increased by similar amounts, though somewhat more for semi-intensive. Both intensive and semi-intensive households started with 35 percent of their cattle herds that were productive females, and both increased this number between baseline and follow-up, to 45 and 40 percent, respectively. This is a key input in MCC's Economic Rate of Return (ERR) model for PURP.

Intensive households also made greater use of fodder, feeding their cows with hay or other prepared fodder for over one additional month in baseline. Surprisingly, while semi-intensive households fed their cattle the same number of days at follow-up, the intensive herders reduced the number of days. This could be due to measurement differences in the baseline and follow-up questionnaires. This interpretation is strengthened by the fact that the actual amount of hay gathered, and the total amount consumed (purchased, gathered, and stored), increased for both intensive and semi-intensive herders over the same period, while being substantially higher for intensive than semi-intensive. There was also a major increase in the number of households that produced alfalfa, which is likely a direct effect of the provision of alfalfa seed by PURP. For alfalfa, like hay, intensive households were more likely than semi-intensive to produce.

The emphasis on improved breed cows and high inputs is also reflected in a 30 percent higher yearly milk yield per cow for intensive households at both baseline and follow-up, while the absolute number increased for both intensive and semi-intensive. Moreover, intensive households were more likely to sell milk in both periods, but the gap actually narrowed between baseline and follow-up, with intensive becoming less likely to sell milk and semi-intensive more likely. In contrast, for those that did sell milk, the gap in earnings from milk sales increased, with intensive households earning nearly three times as much as semi-intensive households in baseline, and nearly 3.5 times as much in follow-up, while both increased by a large amount (but some of this is attributable to inflation). Overall incomes were accordingly substantially higher for households in intensive groups (by over two million MNT in baseline and nearly four million MNT in follow-up), and both intensive and semi-intensive households' income approximately doubled between baseline and follow-up.

Table 12. Comparison of Household-level Characteristics at Baseline and Follow-up, by Intensive and Semi-intensive

	Intensive (Baseline)	Intensive (Follow-up)	Semi-intensive (Baseline)	Semi-intensive (Follow-up)
Percent that did not migrate at all	22	29	12	11
Number of migrations in last year	1.9	1.8	2.3	2.8
Average distance between camps (km)	12.3	9.2	14.2	12.5
Size of herd (sheep units)	342	295	419	444
Percent that own at least one milking cow	81	93	84	95
Percent that own at least one improved breed milking cow	60	76	50	68
Percent of cows that are improved breed	65	70	49	57
Percent of cattle that are productive females	35	45	35	40
Total hay gathered, purchased, and stored (tonnes)	11.0	16.3	7.5	12.2
Total hay gathered (tonnes)	9.2	13.3	6.4	10.5
Percent that produced alfalfa	3.3	17.6	0.8	7.8
Number of days cattle were fed with hay in last year	182	165	147	147
Milk yield (liters per cow per year)	998	1,166	778	887
Percent that sold milk in last year	68	63	48	52
Total earnings from milk sales, for those that sold milk (MNT)	4,869,109	7,275,928	1,730,039	2,151,514
Total income from all sources (MNT)	7,633,955	14,909,886	5,366,899	10,980,054

Tables 13 and 14 explore the difference between intensive and semi-intensive households more by showing the types of animals owned by the households, and the change in herd compositions between baseline and follow-up. In Table 13 it can be seen that the vast majority of households in both groups owned cattle in both baseline and follow-up. About 80 percent of semi-intensive households owned each of horses, sheep, and goats, and the percentages did not change substantially between baseline and follow-up. In contrast, only about 60 percent of intensive households owned each of these animals at baseline, and this decreased to around 50 percent by follow-up. Very few households owned any camels. Table 14 explores the composition of herds in more detail. Semi-intensive households had very mixed herds, at both baseline and follow-up, with two-thirds of the households owning all four major types of animals. Of the remainder, most owned either sheep and goats, or horses, in addition to their cattle. Less than five percent owned only cattle. Moreover, none of these percentages change substantially between baseline and

follow-up. In contrast, the composition of intensive herds changed considerably over the same period. At baseline, intensive households were much less likely than semi-intensive to own all four of the major types of animals (40 percent compared to 70 percent), and by follow-up this had declined to only 26 percent. The percent owning only cattle more than doubled over the same period, with nearly as many intensive households owning only cows as owning all four tpyes of animals. Other combinations changed less between baseline and follow-up for intensive households, but intensive households were substantially more likely than semi-intensive to own cattle plus one or two other types of animal.

Table 13. Percent of Project Households Owning Each Type of Animal, by Intensive and Semi-intensive

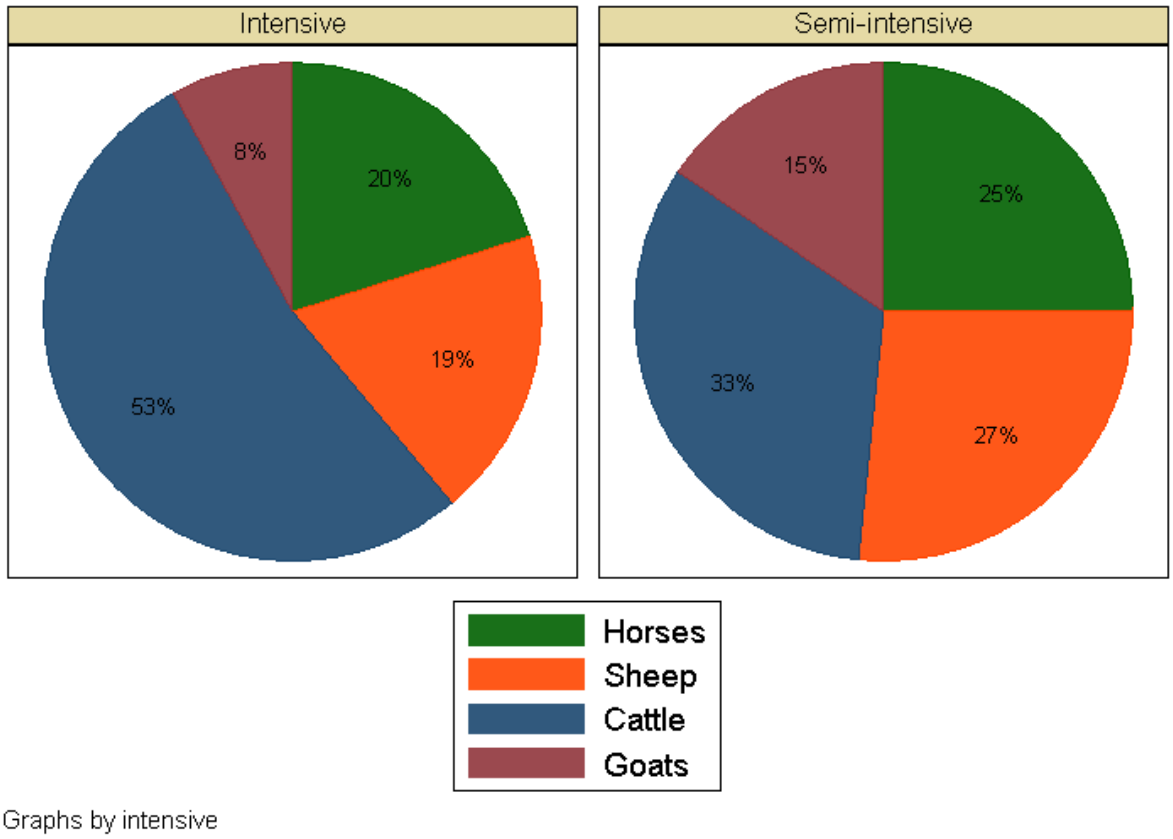
Type of Animal	Intensive (Baseline)	Intensive (Follow-up)	Semi-intensive (Baseline)	Semi-intensive (Follow-up)
Cattle	93	94	94	96
Horse	65	47	84	83
Sheep	59	51	85	82
Goat	60	47	87	85
Camel	1	0	1	1

Table 14. Types of Animals Owned by Project Households, by Intensive and Semi-intensive

Types of animals	Intensive (Baseline)	Intensive (Follow-up)	Semi-intensive (Baseline)	Semi-intensive (Follow-up)
Cow, horse, sheep, goat	39.5	25.9	71.7	70.6
Cow	11.1	23.5	3.0	4.8
Cow, sheep, goat	14.8	17.3	8.3	8.7
Cow, horse	17.3	16	4.6	7.2
Cow, horse, goat	3.7	0.0	3.0	3.3
Other	7.4	11.1	7.2	3.1
No animals	6.2	6.2	2.2	2.2
Total (%)	100	100	100	100

Figure 8 gives the breakdown of herds into relative abundance of each type of animal at the time of the follow-up survey, based on converting animals into sheep units. Intensive herders had much higher representation of cattle in their herds (53% of their herd compared with only 33% for semi-intensive), fewer horses, and much fewer sheep and goats.

Figure 8. Breakdown of Animal Types in Herd, for Intensive and Semi-intensive Households



B. Herder Group Characteristics by Area

This section uses the Herder Group Leader survey to examine the PURP herder groups on a number of dimensions including characteristics of the group members, characteristics of the lease area, and herd size relative to the carrying capacity of the lease area. Table 15 gives information on herder group members broken down by peri-urban area. On most measures the group composition is similar among the three areas. Group members in Erdenet area are slightly less likely to have a female head of household than those in the other areas. Group members in Ulaanbaatar are less likely (by about seven percentage points) to live within the lease area. The average number of households in the group was highest in Darkhan (3.7) and lowest in Ulaanbaatar (3.0), with Erdenet in the middle. Other differences between the areas are very minor. Overall the standardized PURP application process ensured that groups in all areas were similar on average.

Table 15. Group Composition & Demographics of Members

	Darkhan	Erdenet	Ulaan-baatar	All Areas
Number of households in group	3.7	3.3	3.0	3.4
Percent of members who are relatives	74.1	74.2	70.2	72.8
Percent of member households with female head	13.3	9.8	14.4	12.8
Percent of member households with small herd (less than 100 sheep units)	36.1	32.4	33.5	34.3
Percent of member households that live within lease area	85.6	83.7	76.9	82.1

Table 16 presents two different carrying capacity estimates for the PURP lease areas, as well as an estimate of pasture load, for baseline and follow-up.[37] Official carrying capacity was measured using biomass clippings by PURP in mid-2012. In addition, prior to the award of leases, an estimate of carrying capacity was calculated based on the size and vegetation types on the lease, historical average grass yields, and the planned number of days per year that the pasture would be utilized. This is indicated as "Carrying capacity, PURP pre-2010" in the table. The group members were made aware of the calculated capacity of their lease areas and incorporated this information into the "action plan" that they created as part of participation in PURP. Beyond the two calculated carrying capacities, group leaders who responded to the PURLS Herder Group Leader Survey gave their own estimates of the carrying capacity of their lease area. In Erdenet area, group leaders tended to overestimate the carrying capacity in both baseline and follow-up, though the gap narrowed. In Ulaanbaatar, the estimated carrying capacity was much larger than the calculated capacity in baseline, but this switched in follow-up, as the group leaders adjusted their estimate of their own lease areas' carrying capacity substantially downward. In Darkhan, leaders overestimated the capacity at baseline, but at follow-up were accurate on average, but with substantial amounts of both over- and under-estimation. In all three areas, the actual number of sheep units owned by the group members (as measured by the household survey) exceeded the actual carrying capacity and the estimated0020carrying capacity of the group leader, with the exceptions of Erdenet and Ulaanbaatar at baseline, where the estimated capacity exceeded the number of sheep units owned. This suggests that most of the lease areas were being overgrazed at the time of both the baseline PURLS survey, and the follow-up, which occurred in the middle of the project implementation. It is also worth noting that when we compare the estimated capacity from the group leaders to the actual number of sheep units owned, we find that at baseline, in Erdenet and Ulaanbaatar, groups were apparently overgrazing without realizing it (in Darkhan they

[37] Carrying capacity is the maximum number of livestock that an area of pastureland can sustainably support without becoming degraded over time. Pasture load is the number of livestock that are actually being grazed on an area of pastureland. These quantities are typically measured at the soum level, but PURP promoted the use of more fine-grained carrying capacity measurements based on individual lease areas.

realized it), but at follow-up, groups were knowingly overgrazing their lease areas in all three areas. It is important to note that the number of animals owned by group members is not a perfect measure of the pasture load of the lease area, since many group members herd some of their livestock outside the lease area for at least part of the year. Thus the numbers presented in Table 16 are an upper bound on the actual number of animals being grazed on the lease area, so the conclusion that overgrazing is occurring cannot be made with much confidence based on this data. Much more detailed information on the intensity of use of the lease area pasture will be collected in the second follow-up survey.

Table 16. Pasture Carrying Capacity and Pasture Load (Sheep Units)[1]

		Darkhan	Erdenet	Ulaanbaatar	All Areas
Baseline	**Carrying capacity, Herder Group Leader Survey**	1,412	1,346	1,255	1,342
	Carrying capacity, PURP pre-2010	1,214	804	750	954
	Number of sheep units currently owned by group	1,692	1,292	1,091	1,388
Follow-up	**Carrying capacity, Herder Group Leader Survey**	1,183	1,165	808	1,050
	Carrying capacity, PURP 2012	1,140	877	986	1,021
	Number of sheep units currently owned by group	1,340	1,233	1,105	1,233

[1] The baseline and follow-up figures are not directly comparable because different subsets of the groups had non-missing data in the two periods, with most missing data coming from the estimated carrying capacity from group leaders.

Table 17 takes another look at carrying capacity, specifically looking at the percentage of herder groups whose herd size (as measured by the members' household surveys) was below the carrying capacity of their lease area (as measured in 2012 by PURP). There was no substantial change overall, although when comparing areas, groups in Ulaanbaatar area became less likely to restrict their herd to below the carrying capacity, while Darkhan area groups became more likely to meet that goal. However it is important to note that carrying capacity is a complex concept and the actual number of animals that a given piece of land can sustain varies greatly from year to year based on weather, and also depends on how long it is grazed during the year. Thus changes in animal numbers may be following unobserved changes in carrying capacity, rather than reflecting movements toward or away from a stable carrying capacity number. For this reason, the apparent lack of change in these percentages seen in Table 17 cannot be considered as strong evidence that herder groups are not changing their herding practices to be more sustainable.

Table 17. Percent of Groups Maintaining Herd Size Below the Carrying Capacity of their Lease Area

	Darkhan	Erdenet	Ulaanbaatar	All Areas
Baseline	32.6	35.2	53.4	40.3
Follow-Up	39.3	37.0	42.5	39.8

Table 18 gives a picture of the natural and social environment surrounding the lease areas in each peri-urban area. The numbers in this section are as reported by herder group leaders in the PURLS follow-up survey. Almost 90 percent of lease areas in Ulaanbaatar contained some type of well, with 83 percent in Erdenet and 77 percent in Darkhan. The majority of well drilling by PURP had been completed at the time of the survey, which accounts for the high prevalence of wells in all three areas. Over half of lease areas in Darkhan contained a river or stream, compared with only 30 percent in Ulaanbaatar and 37 percent in Erdenet.[38] Substantial numbers of leasing areas near all three cities contained a hay or cropping area of a non-member, including over one-third of lease areas in Darkhan area, one-fourth in Ulaanbaatar and 15 percent in Erdenet. About one-fifth of lease areas in Darkhan and Erdenet areas, and 30 percent of those in Ulaanbaatar area, contained pasture that was used by non-group members. Similarly, 35 percent of lease areas in Darkhan and Erdenet area, and 47 percent in Ulaanbaatar area, contained a passage area used by non-members.[39] These may reflect a higher population density in the area surrounding Ulaanbaatar, but surprisingly, Ulaanbaatar area leases also had the lowest number of neighbors within two kilometers of their borders, which may be a result of the districts of Ulaanbaatar (which contain extensive pastureland immediately surrounding the city) pulling out of the project at the last minute, which meant the project was only active in more remote areas. In fact, Darkhan area lease had almost twice as many neighboring winter camps than Ulaanbaatar area leases.

Table 18. Features and People in Proximity of Lease Area

	Darkhan	Erdenet	Ulaanbaatar	All Areas
Lease area contains Well	77.3	83.3	89.3	82.9
Lease area contains River or stream	53.4	37.0	30.7	41.5
Lease area contains Hay-making or cropping area of non-member	35.2	14.8	24.0	26.3
Lease area contains Grazing area of non-member	21.6	18.5	30.7	24.0
Lease area contains Passage area of non-member	36.8	35.2	46.7	39.8
Number of winter camps with 2 km of lease area boundary	3.0	2.5	1.7	2.4
Number of spring camps with 2 km of lease area boundary	1.2	1.2	1.1	1.2

[38] PURP leases were not supposed to contain rivers or streams, though in many cases a river formed a boundary of a lease area or divided a lease into two parts. In these cases the group leaders likely interpreted the river as being contained within the lease area.

[39] PURP made efforts to ensure that all lease areas did not contain pasture or cropping areas used by non-members, but these numbers suggest that their efforts were not 100 percent effective. No additional details were obtained from the PURLS survey, such as the relationship of the non-member in question with the group members.

C. Gender Analysis of Project Groups and Households

The preceding analysis has focused on overall levels of variables in PURLS Phase I. In this section we turn to a description of gender differences. Specifically, we look at differences between households with female and male heads of household, across a range of variables. These statistics are reported only for households that were members of the 234 herder groups that participated in the PURP project.

Table 19 below reports the percentage of female and male heads of households and herder group leaders.[40] The household heads were self-reported by the respondent or respondents surveyed from each household. As is evident, men led the vast majority (about 90%) of households and herder groups. Table 19 also presents the gender of primary survey respondents, which was recorded by the enumerator while they administered the survey. Though only about 10 percent of all household heads were female, overall 39 percent of primary respondents were female. This shows that women who are not considered household heads still have extensive knowledge of the household's livestock and economic activities.

Table 19. Gender of Head of Household, Interview Participants, and Herder Group Leader

Head of Household	**Percent**
Male	89.2
Female	10.8
Primary Respondent in Household Survey	
Male	61.4
Female	38.6
Herder group Leader[1]	
Male	91.7
Female	8.3

[1] Gender of the herder group leader was taken from the PURLS Herder Group Leader survey.

Table 20 presents demographic and other basic household characteristics of project beneficiaries, broken down by the gender of the household head. Female-headed households (FHHs) were substantially smaller than male-headed households (MHHs), by 1.3 members on average. This is mainly due to MHHs having one additional child, on average, but they also had on average 0.4 additional adult members. MHH heads had one additional year of education than FHHs. FHH and MHHs on average live with the same number of households at their winter camp (a group of households living together is called a "hot ail"), and they also had similar rates of owning a possession certificate for their winter or spring camps.

[40] As noted earlier, in Mongolia, when a married couple leads a household, the husband is automatically considered the head. Thus a female head of household is usually widowed or divorced.

Table 20. Demographics and Basic Household Characteristics, by Gender of Household Head

	Female	Male
Number of Household Members	2.8	4.1
Number of Household Members Over 18	2.3	2.7
Number of Household Members Under 18	0.5	1.4
Years of Schooling of Household Head	8.2	9.2
Members in Hot Ail at Winter Camp	1.7	1.7
Household Owns Winter or Spring Camp Possession Certificate (%)	73.3	72.5

Figure 9 shows the number of seasonal camps used by gender of the household head. MHHs were much more likely to use three or four seasonal camps, while female-headed households were more likely to use only two seasonal camps or remain at a single camp the whole year. The potential reasons for using multiple camps are complex, but one factor is that moving to new pastures is a relatively labor-intensive process, and households with fewer members are likely to find moving between seasonal camps more difficult. Since we saw in the previous table that FHHs are smaller, this could explain part of the difference camp usage patterns.

Figure 9. Number of Seasonal Camps, by Gender of Household Head

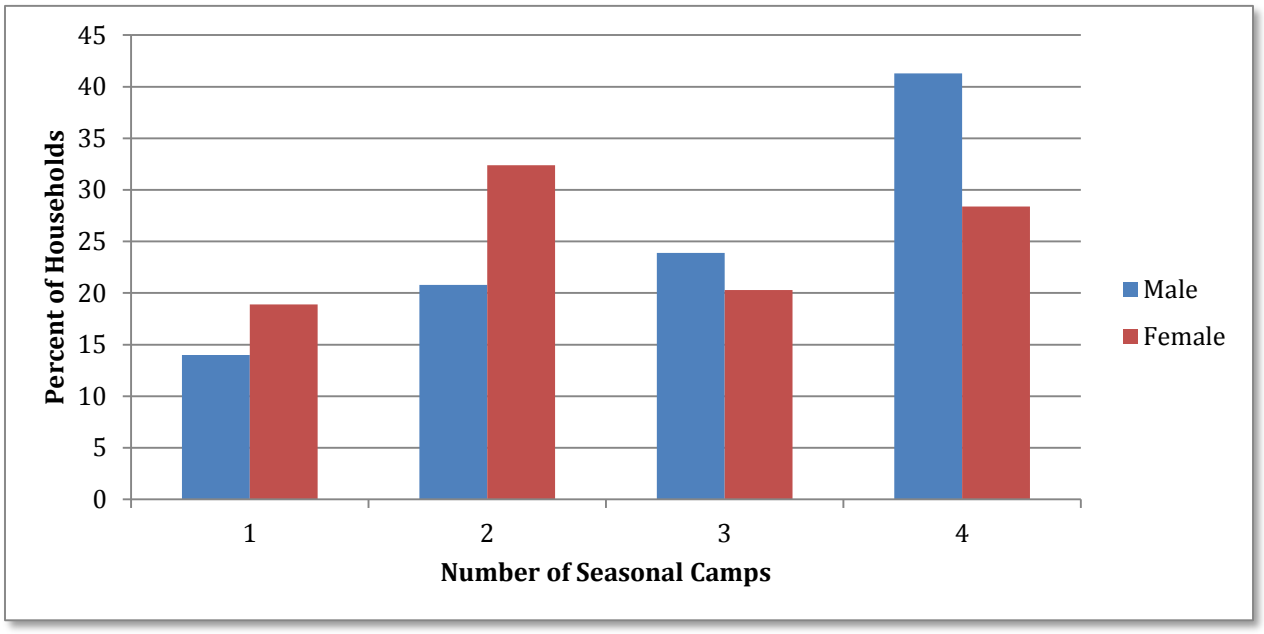


Table 21 shows the number of households that were below the poverty line during the baseline and follow-up surveys. It appears that the number of households below the poverty line dramatically decreased between baseline and follow-up, from nearly 60 percent to only 35 percent of all project households. However there are at least two strong caveats that need to be considered when interpreting these numbers. The first caveat is that the poverty line, which is calculated yearly

by the Mongolian National Statistics Office, is based on overall consumption, and is meant to include the value non-purchased consumption including shelter and food. However, the PURLS survey did not collect sufficient information to impute monetary values for many of the categories of non-purchased consumption, so yearly income was deemed to be the most appropriate measure from PURLS to compare to the poverty line. Using income as a proxy for consumption is problematic for this population, since herders are heavily dependent on home production of food, and own their ger, so they are to a large extent independent from markets for their basic necessities. Large relative increases in herder income may thus represent relatively small changes in consumption as conceived by NSO. Thus although PURP beneficiary households earned much more money in the follow-up, this may not have affected their level of consumption substantially, certainly not to the extent that nearly half of those in poverty came out of it during this two-year period.

The second major caveat is that baseline was a dzud year, and this likely substantially impacted the herders' ability to make money, both because they lost animals due to the dzud and had to quickly sell animals at risk of dying, which resulted in lower prices paid due to limited bargaining power and oversupply. Although the baseline data collection period was clearly a very difficult time for herders and their welfare reduction after the dzud was real, it is a mistake to interpret the observed reduction in poverty rates as a long-term phenomenon, because incomes were depressed compared to usual levels during the initial measurement.

Table 21. Percent of Households Below Poverty Line, by Gender of Household Head

	Baseline Survey	Follow-up Survey
Male-headed Household	58.1	35.5
Female-head Household	54.4	36.5

Table 22 shows households' average total income during the baseline and follow-up surveys. MHHs had much higher average income for both surveys, nearly twice as high during baseline and about one-third higher during follow-up. Note that although the poverty rates of MHHs and FHHs were similar during both baseline and follow-up surveys, the actual income was much higher for male-headed households. This reflects both the fact that poverty is based on per-capita income and MHHs were larger, and also a higher average income for MHHs among those that were above the poverty line.

Table 22. Average Household Income, by Gender of Household Head

	Baseline Survey	Follow-up Survey
Male-head Household	5,975,776.6	11,918,172.7
Female-headed Household	3,050,144.7	7,933,684.6

Tables 23 and 24 examine differences in investment between male- and female-headed households. Investment in immovable property in the past year was 84 percent higher for MHHs than FHHs at baseline, and had grown to 103 percent higher by the follow-up survey. Investment more than doubled for both MHHs and FHHs, but this was partly attributable to inflation. Investment in livestock was also higher for MHHs, and differed in the pattern of investment as well as the quantity. MHHs were much more likely (24 percent versus 14 percent) in have invested

in purchasing improved breed cattle in the two years between the surveys. Those that invested in these cattle, however, invested similar and substantial amounts, on average 2.5 million MNT, which is nearly 83% of average yearly income for FHHs. None of the FHHs and only 3.5 percent of MHHs invested in purchasing Mongolian cattle. MHHs were slightly more likely to invest in purchasing other types of livestock, and invested much more money when they did purchase those livestock (2.5 million for MHHs and 1.5 million for FHHs). Overall, MHHs were observed to have much higher investment in both livestock and immovable property, which probably reflects to large extent the higher average incomes of MHHs.

Table 23. Investment in Immovable Property, by Gender of Household Head

	Female	Male
Investment in Immovable Property in Past Year (MNT) (Baseline)	293,529	540,850
Investment in Immovable Property in Past Year (MNT) (Follow-up)	649,647	1,321,507

Table 24. Investment in Livestock in Past Two Years, By Gender of Household Head

	Female	Male
Improved Breed Cattle, Yes/No	13.7	24.4
Improved Breed Cattle, If Invested	2,564,286	2,640,576
Improved Breed Cattle, Average	351,961	643,930
Mongolian Cattle, Yes/No	0.0	3.5
Mongolian Cattle, If Invested	.	1,700,000
Mongolian Cattle, Average	0	59,649
Other Livestock, Yes/No	7.8	9.3
Other Livestock, If Invested	1,562,500	2,551,827
Other Livestock, Average	122,549	232,798

Table 25 presents the change in herd size for male- and female-headed households from baseline to follow-up. We can see that in both periods MHHs had larger herds. However, while MHHs decreased their herd size on average, FHHs increased their herd size. This seems to contradict the higher average investment in purchasing animals by MHHs, so it must reflect a larger degree of culling or selling off animals among MHHs. This difference will be important to note when looking at project impact on herd size in Section VI. It should also be noted that while lower herd sizes are positive when pastureland is being overgrazed, if a household is very poor then an increase in herd size is a large boost in household wealth and welfare. The increased herd sizes among FHHs, which own much fewer animals on average, can be considered a positive result as well, as it is increasing wealth equality among genders within the herder groups.

Table 25. Herd Size (Sheep Units), by Gender of Household Head

	Baseline Survey	Follow-up Survey
Male-head Household	428	442
Female-headed Household	248	283

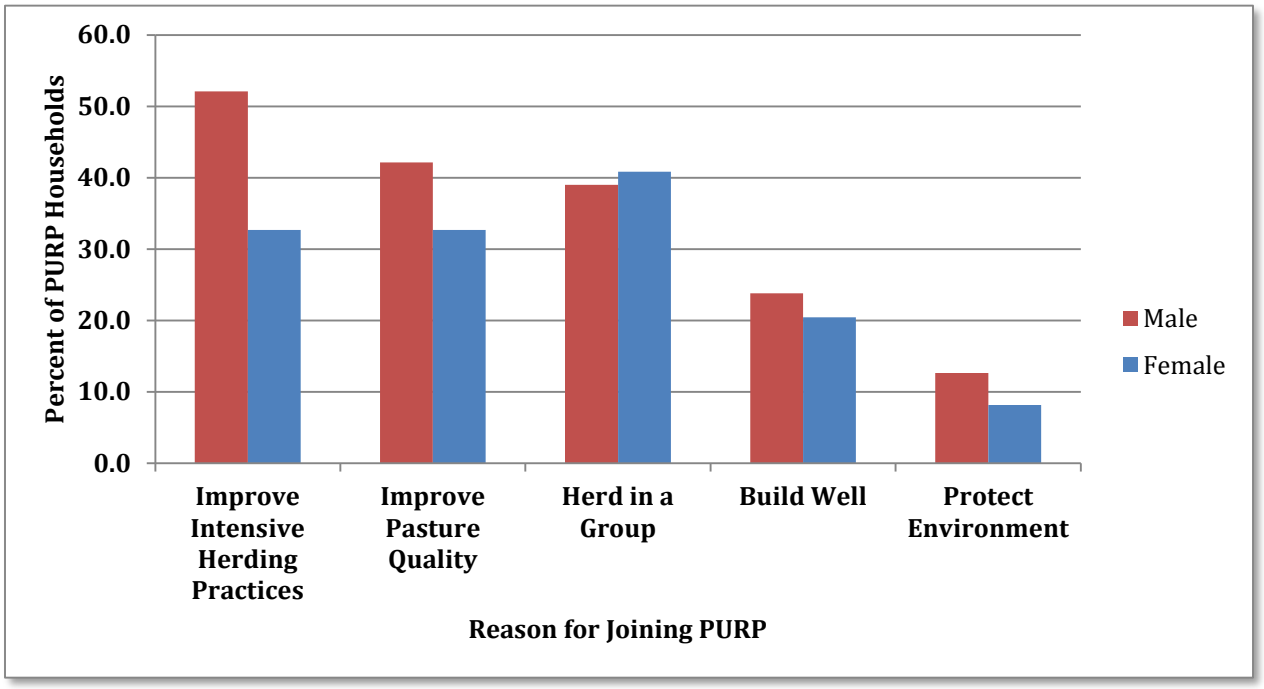
An important aspect of PURP was to allow herders to more easily resolve land conflicts. Both male- and female-headed households were similarly likely to have experienced a pastureland-related conflict in the previous five years (this was measured during the follow-up survey), as shown in Table 26. One concern was that FHHs would be more vulnerable to invasion of traditional pasturelands by outside herders, but there is little evidence of this at the time of writing. Very little detailed information on land conflicts was collected in the baseline and follow-up surveys, thus it is unclear whether the resolution of these conflicts was favorable or unfavorable to the household. Additional details on land-related conflicts will be collected in any future follow-up surveys that may be conducted.

Table 26. Pastureland Related Conflicts, by Gender of Household Head

	Female	Male
Percent of Households with Pastureland-Related Conflict in Past Five Years	11.8	12.1

Figure 10 presents the main reasons that households indicated for why they wanted to join the PURP. These reasons differed substantially between male- and female-headed households. For MHHs, the desire to improve "intensive" herding practices was the top reason for joining, followed by improving pasture quality and herding in a group. The order of these top three reasons was reversed for FHHs. The fourth and fifth most common reasons were to get help for building a well, and to protect the environment. Other reasons such as jointly preparing hay, to increase household income, and to gain access to pastureland, were indicated by fewer than 10 percent of PURP beneficiaries.

Figure 10. Motivations for Joining PURP, by Gender of Household Head



VI. Household Survey Results and Impact Analysis[41]

This section presents results from the Household survey, including formal impact analysis. First the PURP project logic is discussed in detail, including plans for measuring each of the components of the project logic using PURLS, and limitations of existing measures. Then the three main causal pathways in the project logic are each examined. Some descriptive statistics from the follow-up survey are presented, which give context to the impact analysis, along with results of regression models designed to decipher project impact. Finally, a summary is given of the major measured effects of the project.

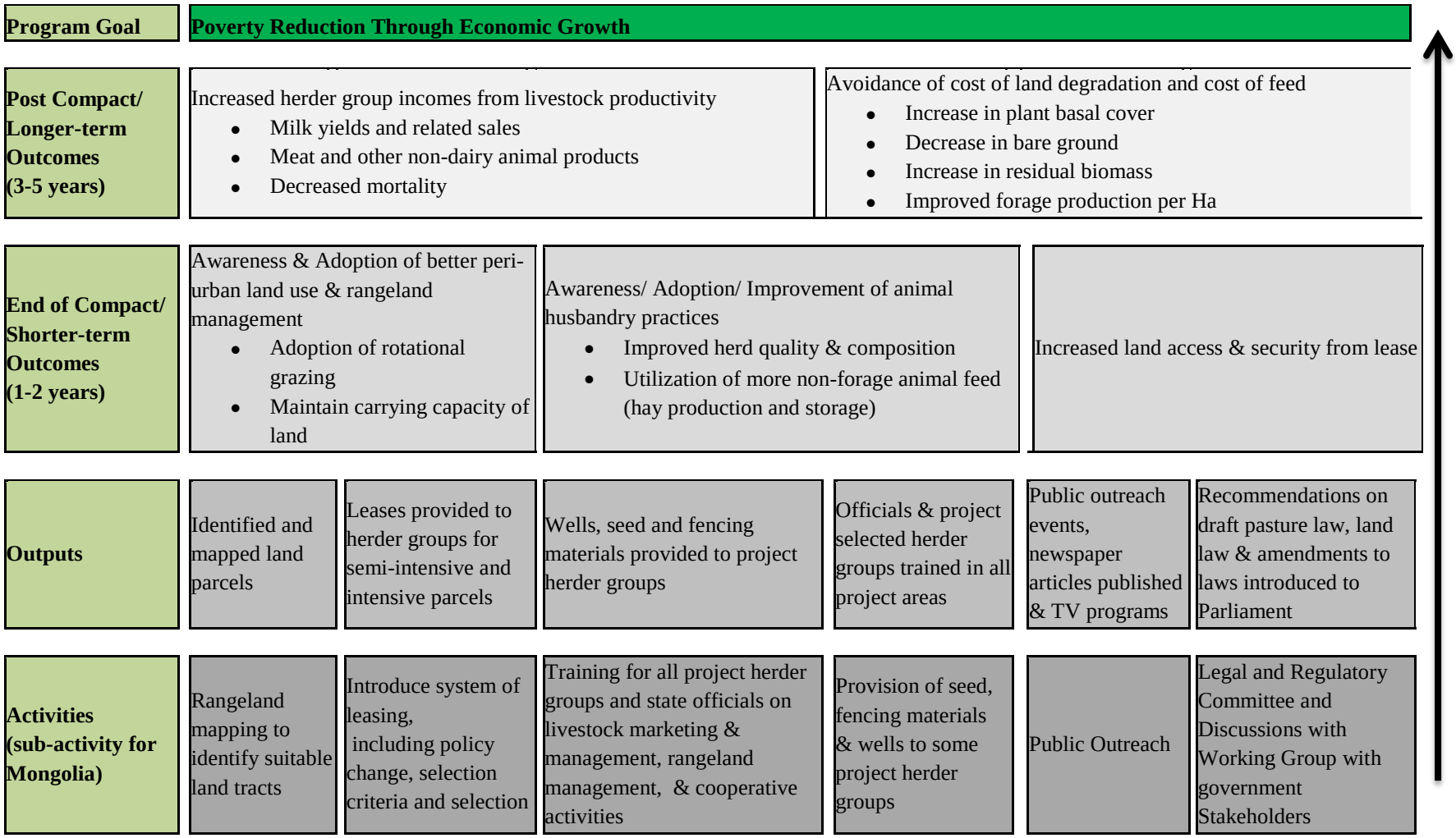
A. Peri-Urban Rangeland Project Logic

Figure 11 presents the logic of the project as seen by MCC and the MCA-M PURP project implementation unit. The bottom row presents project activities. The second row up gives the direct project outputs, discussed in Section IV above. The top two rows correspond to short and long-term outcomes, respectively. Different outcomes are expected to improve for project households at different points in time after the project activities have finished. Specifically the short-term outcomes were expected to manifest by the end of the compact, or one to two years after the beginning of project implementation. The follow-up survey was conducted approximately two years after the provision of leases in the Phase I areas, so it corresponds well to the timeframe of the short-term outcomes.[42] Long-term outcomes are expected to manifest on a longer time horizon, at least three to five years after the start of project activities. The remainder of the household analysis will be organized around these short- and long-term outcomes.

[41] This section only considers households with complete data from both baseline and follow-up surveys.

[42] Although the follow-up was conducted approximately two years after the provision of leases, other project assistance was not distributed until later, as detailed in Table 1. Thus the survey can capture only very short-term effects of the other aspects of project implementation.

Figure 11. PURP Logic Framework



The PURP project logic can be split into three major pathways leading from project activities to desired outcomes, each with associated short- and long-term outcomes. The short-term outcomes are generally behavioral changes that the project hoped to bring about, such as reducing overall herd size, and increased usage of hay for feeding animals. These short-term behavioral changes are then expected to give rise to longer-term outcomes that reflect an improvement in household welfare and environmental sustainability, such as increased income from livestock, and improved pasture quality. The three major pathways are:

1. Improved rangeland management resulting in environmental sustainability
2. Improved animal husbandry resulting in increased income from animal products
3. Increased land tenure security and resulting investment in improvements on the land.

A detailed breakdown of the project logic outcomes is provided in column 1 of Table 27, and associated measures from the PURLS survey are listed in column 2. Additions to future follow-ups or data collected by other means than PURLS are listed in column 3. This table also includes the indicators that MCC has chosen to track, and how they fit within the broader framework of the project logic. These indicators are listed in boldface text. A full list of indicators that IPA had provided to MCC at of the time of publication of this report is included in Appendix D.

Table 27. PURP Detailed Project Logic with Associated PURLS Measurements

Causal Pathway 1: Improved Pastureland Management		
Outcomes from Project Logic	**Measures in PURLS**	**Other/ Planned Measures**
Short-term outcome 1: Awareness & Adoption of better peri-urban land use & rangeland management		
Adoption of rotational grazing	Number of migrations in past year	More detail on grazing patterns will be collected in future follow-up surveys
Maintain carrying capacity of land	• Herd size (sheep units) • **MCC Indicator:** Percentage of herder groups with leases having no more than the maximum number of sheep units of livestock per 100 ha (carrying capacity of land) as specified in their leases	Percent of groups maintaining their herd at or below carrying capacity will be more accurately measured in future follow-ups; accurate numbers not available in baseline because only the total number of animals owned by group members was collected and group members often do not herd all of their animals within the lease area
Long-term outcome 1: Avoidance of cost of land degradation and cost of feed	Perceived quality of pasture at winter and summer camps	**MCC Indicator:** Average air-dry weight (in kg/ha) of total standing biomass of uncaged areas in project sites ➔ To be measured directly in USDA's Land Productivity Study

Causal Pathway 2: Improved Animal Husbandry Practices		
Outcomes from Project Logic	**Measures in PURLS**	**Other/ Planned Measures**
Short-term outcome 2: Awareness/ Adoption/ Improvement of animal husbandry practices		
Improved herd quality & composition	Change in each animal (as percent of sheep units): • improved breed milking cows • other cattle • sheep • goats • horses	
Utilization of more non-forage animal feed	• Days that cattle were fed with hay / fodder • Percent that gathered their own hay • Percent that grew other fodder	
Long-term outcome 2: Increased herder group incomes from livestock productivity		
Net Earned Income	• **MCC Indicator:** Net earned income of participating project herder households including agricultural net income, wages, and other business profits (excludes government transfers and unearned income)	
Improved milk yields and related sales	• **MCC Indicator:** Annual average milk production per cow • Total earnings from milk sales	
Income from meat and other non-dairy animal products	• Total income from selling animals • Total income from selling cashmere, airag, and other animal products (besides cow milk)	Sales of meat will be separated out from sales of live animals in future follow-up surveys
Decreased mortality	• **MCC Indicator:** Herd mortality rate (natural causes and sickness-related deaths) of project herder groups (Cattle) • **MCC Indicator:** Herd mortality rate (natural causes and sickness-related deaths) of project herder groups (Sheep) • Mortality rate of goats • Mortality rate of horses	

Causal Pathway 3: Improved Land Tenure Security		
Outcomes from Project Logic	**Measures in PURLS**	**Other/ Planned Measures**
Short-term outcome 3: Increased land access & security from lease		• Percent of households who feel secure with their tenure on their pastureland (to be measured in future follow-up surveys) • Ability to restrict others from using the land(to be measured in future follow-up surveys)
Long-term outcome 3a: Increased investment in improvements and repairs on the land	• Total investment in immovable property in past year • Percent with well access at summer and winter camps	More information on investments in the land, including animal shelters and fencing of haymaking and cropping areas, will be collected in future follow-ups and will better account for the impact of direct project assistance in these areas.
Long-term outcome 3b: Improved ability to resolve pastureland-related conflicts, and reduction in such conflicts		
Reduction in land conflicts	Percent with a pastureland-related conflict in past 5 years	More detail on pastureland conflicts will be collected in future follow-up surveys

B. Household Descriptive and Impact Analysis by Peri-Urban Area

The household is the only unit of analysis at which a meaningful impact analysis is possible. This is because PURP herder groups do not have close equivalents outside the context of the project. The only other groups to which they could be compared are groups that were rejected during the selection process for PURP Phase I. However, the rejected groups are different from project beneficiaries in many ways, which directly impacted on their eligibility for the project. Thus IPA and MCC decided that using rejected herder groups as comparisons for project herder groups was not a viable option. Instead, the matching design described in Section I.C was developed, using non-project households as the comparison group. The results from the impact analysis using this study design are presented in this section. The remainder of the section is organized around the three main causal pathways identified in the PURP logic model, and short- and long-term outcomes are discussed in turn.

The statistical model used to determine project impacts was based on the full matching technique described in Section I.C. This technique essentially creates a number of small groups of similar households. Then within these groups, the difference in the average value of the outcome of interest is calculated. These within-group averages are then combined using a weighted average with weights determined by the fraction of the treatment households in the group. The result is an estimate of the Average Treatment Effect on the Treated (ATT). In other words, this is a measure of the effect of the project on the actual project households, but one should be cautious in extrapolating this effect to other herder households in Mongolia, since the project might have affected these households differently. Statistical significance was determined using a weighted regression model with "project household" as the coefficient of interest, with fixed effects for the matching group, weights equal to the ratio of project to comparison households in the matching group, and standard errors clustered in the following way: for project households, the cluster was the herder group. For non-project households, the cluster was the soum.

The majority of tables in this section present the mean value of an outcome for project households, for both the baseline and follow-up surveys. Then the change between baseline and follow-up surveys is listed, and then the change between baseline and follow-up for the comparison group is presented for comparison. The actual values in baseline and follow-up for the comparison group were not presented, because these are weighted quantities constructed from the matching exercise and do not represent the mean of any real population of households. Instead only the baseline/ follow-up change was presented because that quantity alone was used for the impact analysis. Finally a p-value from the impact regression is presented, for judging the statistical significance of the difference in the baseline/ follow-up change between project and comparison households. This difference-in-difference method was chosen for measuring project impact because it does not depend on equality of means in the baseline, which was necessary because the study design was not based on random assignment to the project. Thus when we find a difference to be "statistically significant" it means that the project appears to have had an effect on how the outcome changed over time. It does not necessarily mean that the treatment households had a higher value of the outcome at the time of the follow-up survey. For all discussion below, a difference is considered to be statistically significant if it had a p-value of 0.05 or less, and we classify a p-value between 0.05 and 0.1 as marginally significant.

We present our findings separately by the three project areas, and in most cases an overall estimate combining data from all three areas is presented. The separation of areas was deemed necessary because for many outcomes opposite trends are seen in different areas, so important effects may be missed by grouping all areas together.

i. Causal Pathway 1: Improved Pastureland Management

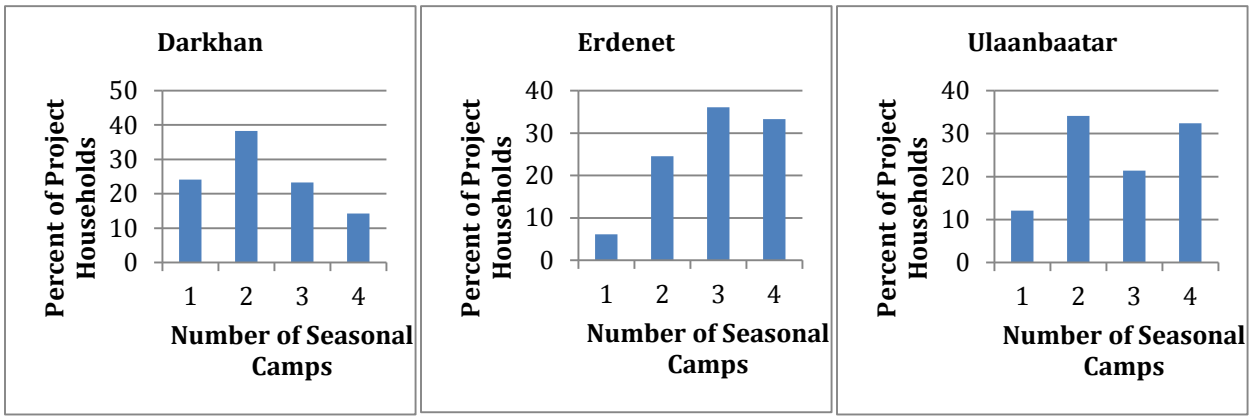
The first thread of the project logic we will examine is the awareness and adoption of better peri-urban land use and rangeland management. This outcome is especially related to the exclusive-use land lease component of the project, but the trainings also extensively addressed this topic. IPA's ability to analyze this thread of the project is currently limited due to lack of detailed questions on grazing patterns in the PURLS surveys. These questions will be added in the case of future follow-up surveys. Moreover, a parallel study of the pastureland quality on PURP leases areas using physical measurements of the land is currently being conducted by USDA and the results of that study will provide the best data on the effects of the project on pastureland quality.

a. Short-term Outcome 1: Awareness and Adoption of Better Peri-Urban Land Use & Rangeland Management

Adoption of Rotational Grazing

Figure 12 shows the migration patterns of project households at the time of the baseline survey. Households in Darkhan area were the most likely to be sedentary, with nearly a quarter not moving at all. In contrast, that number is closer to 10 percent in Ulaanbaatar and five percent in Erdenet. Ulaanbaatar has large numbers of households migrating two times (usually a summer and winter camp) and four times (four seasonal camps), while in Erdenet the most common pattern is to use three camps (usually winter, spring, summer/autumn), or four camps.

Figure 12. Number of Seasonal Camps at Baseline, Project Households



The PURP promoted rotational grazing as a way of reducing land degradation, by allowing land to recover after a period of grazing by livestock. Rotational grazing can occur by seasonal migration to new pastureland, and also within seasons by restricting animal grazing to specific areas. The PURLS survey collected information on seasonal migration but not within-season pasture rotation, so the ability to discern project impact on rotational grazing is incomplete. Table 28 presents results of an impact regression on the number of seasonal migrations in a year. Increased seasonal migration implies that fewer pastures are being used for multiple seasons in a single year, which could lead to improved pasture quality. But increased migration could also be caused by depletion of pasturelands, forcing households to migrate to find suitable pasture for their animals. And in this case, only households with sufficient resources would be able to move to better pastures. In any case at the time of the follow-up there was no evidence of project impact on this outcome.

Table 28. Project Impact: Average Number of Moves per Year

Peri-Urban Area	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	2.12	2.52	0.40	0.40	0.97
Erdenet	3.17	3.16	-0.01	-0.11	0.33
Ulaanbaatar	2.79	2.69	-0.09	0.04	0.38
All Areas	2.57	2.73	0.16	0.17	0.86

Maintain Carrying Capacity of Land

Herd size is a crucial outcome, because it is the best measure available to capture the effects of the project on behavior related to pasture sustainability.[43] In particular, the project encouraged herder groups to maintain their herd sizes below the carrying capacity of their leased land. Since there are no comparable herder groups or carrying capacity measurements for comparison households, we need to use the change in herd size as evidence of movement toward or away from a sustainable number of animals. It was shown in section V.B that approximately 60 percent of groups were not maintaining their herd sizes below the carrying capacity of their land. This, in conjunction with the basic assumption of the project that pastureland was being overgrazed, lead us to look at a decrease in animal numbers as a positive outcome of the project. There are two main caveats to this interpretation. First, accurate numbers for "grazing intensity" are not available because only the total number of animals owned by group members was collected. Group members often do not herd all of their animals within the lease area, and thus the number of animals owned by group members is an upper bound on the actual number of animals grazing on the lease area. More detailed information on grazing patterns that will allow for better estimates of grazing intensity will be collected in future follow-up surveys. The second caveat is that carrying capacity was only measured at a single point in time by PURP specialists, specifically in the summer of 2012. Carrying capacity is a complex concept and the actual number of animals that a given piece of land

[43] Herd size is measured in sheep units. A "sheep unit" is a generic way of measuring "number of livestock" that takes account of the differing size of animals. Goat = 0.9, Sheep = 1, Camel = 5.7, Cattle = 6, Horse = 6.6

can sustain varies greatly from year to year based on weather and the grazing patterns of the herders. Thus changes in animal numbers may be following unobserved changes in carrying capacity, rather than reflecting movements toward or away from a stable carrying capacity number.

Table 29 presents the project impact on overall herd size, measured in sheep units. There were substantial differences between the three areas on this outcome. Darkhan Project households decreased their herd size by an average of 55 sheep units between baseline and follow-up, though Comparison households also decreased their herd size and the difference was not statistically significant. Erdenet Project households maintained their herd sizes at approximately the same level, while Comparison households decreased their herd size, though the difference was not strong enough to be statistically significant. In Ulaanbaatar area, Project households maintained their herd sizes at approximately the same level, while Comparison households increased herd sizes, and this difference was statistically significant. Thus there is some evidence that at least in the Ulaanbaatar area, project households were attempting to control their herd sizes, which was a key goal of the project.

Table 29. Project Impact: Herd Size (Sheep Units)

Peri-Urban Area	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	458	403	-55	-50	0.76
Erdenet	472	479	7	-19	0.26
Ulaanbaatar	469	474	5	54	0.03
All Areas	465	442	-22	-13	0.41

b. Long-term Outcome 1: Avoidance of Cost of Land Degradation and Cost of Feed

Table 30 presents measures of the PURP project impact on pastureland quality. The measures reported are perceived pasture quality at the summer and winter camps. It should be noted that since these are subjective self-reports of pasture quality, strong conclusions should not be drawn from the impact estimates. In particular, the project may have impacted perceptions of land quality without actually affecting land quality in an objective sense. Moreover, since the locations of summer camps in particular change from year-to-year, it is difficult to interpret the change in summer camp quality. And yearly fluctuations in the pasture quality due to weather can be interpreted differently by different herders, so a reported improvement may be due to simply less harsh winter, or maybe be due to a general trend of improvement. This is particularly important because the baseline survey asked about the pasture quality at winter camp during a dzud year, while the follow-up asked about the quality during a more typical winter. Finally, the follow-up survey was conducted only two years after the award of leases, and the project impact on land quality is not expected to manifest for several years later. That being said, there were detectable differences in the change in perceived winter camp quality between Project and Comparison households in Darkhan and Ulaanbaatar. In both areas, Project households perceived a greater improvement than Comparison households. It is important to note that, despite being detectable statistically, the actual differences between Project and Comparison are small in all three areas. No statistically detectable project effects were found on summer camp quality.

Table 30. Project Impact: Perceived Pastureland Quality[1]

Peri-Urban Area	Season	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	Winter	3.1	3.4	0.2	0.0	0.00
	Summer	3.5	3.6	0.1	0.1	0.77
Erdenet	Winter	3.1	3.6	0.4	0.3	0.30
	Summer	3.5	3.6	0.0	-0.1	0.51
Ulaanbaatar	Winter	2.9	3.4	0.5	0.3	0.03
	Summer	3.3	3.6	0.3	0.3	0.98
All Areas	Winter	3.1	3.4	0.4	0.2	0.00
	Summer	3.5	3.6	0.1	0.1	0.59

[1]Pasture quality was rated on a scale from 1 to 5, with "1" = "Very Low" and "5" = "Very High". The mid-point of "3" was meant to correspond to land that is just supporting the maximum number of livestock, but could support no more.

c. Summary of Causal Pathway 1

At the time of the follow-up survey, some project impacts were beginning to appear for the first causal pathway. The most significant effect was a decrease in herd size for project relative to comparison households in the Ulaanbaatar area. It should be noted that although this result was strong in Ulaanbaatar, there was no observed difference in Darkhan and the difference in Erdenet was in the opposite direction (though not statistically measurable), so the project seems to have had quite varying effects on herd size across the three areas. The fact that herd sizes grew less in Ulaanbaatar could be due to the dzud in baseline, which was by far the most severe in this area, as can be seen in Figure 16 below. While comparison herders likely increased their herd size to recover from the heavy losses from the previous winter's dzud, project households may have chosen to keep their herd at the lower level rather than actively increasing its size. Since the dzud was less severe in Darkhan and Erdenet, decreasing herd size would mean actively selling off or slaughtering their animals, which is much more difficult and costly than simply not replacing lost animals. In addition to the effect on herd size, the perceived pasture quality at winter camps also increased relative to comparison households in two areas, but due to the subjectivity of the measure, not much weight should be placed on this result. There was no evidence of a project effect on seasonal migration. Due to limitations of self-reported land quality, PURLS is not a very strong measurement instrument for the final outcomes of this causal pathway. However, there is no need to rely on the PURLS measures in isolation because a parallel study by USDA is collecting physical measurements on land quality which will allow for much more objective judgments of project impact.

ii. Causal Pathway 2: Improved Animal Husbandry Practices

The second thread of the project logic we will examine is the awareness and adoption of improved animal husbandry practices, including increase use of hay and fodder, and a switch to more productive breeds of milking cows. The ultimate result of these changes is expected to be an

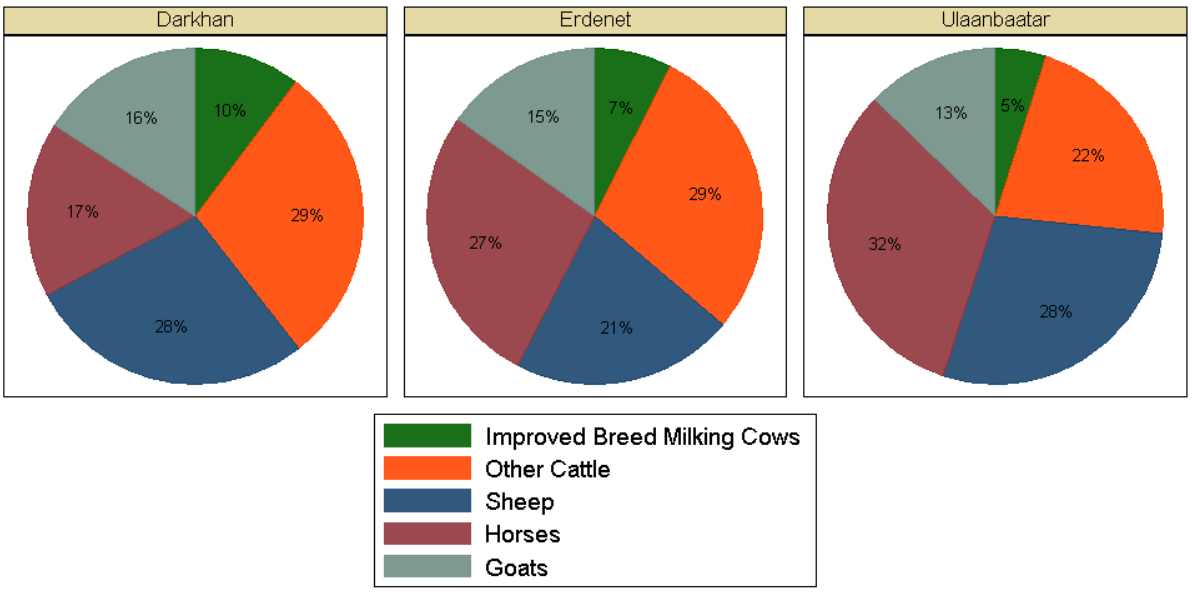
increase in household incomes from increased production and sales of livestock products. This pathway is especially related to the training component of the project. The PURLS survey collected extensive information on animal husbandry practices including usage of hay and fodder, and costs of animal husbandry, allowing us look at these behavioral changes in the use of various inputs and purchase of cattle breeds, as well as any preliminary effects on income.

a. Short-term Outcome 2: Awareness/ Adoption/ Improvement of Animal Husbandry Practices

Improved Herd Quality and Composition

A key focus of the project was to instigate a switch from animal quantity to animal quality, in order to reduce grazing intensity while simultaneously improving the per-animal productivity of the herd, mitigating potential lost income from reducing the size of the herd. Figure 13 gives a graphical display of the herd compositions of Project households at the time of the follow-up survey.

Figure 13. Animal Composition of Herds at Follow-up, Project Households



Graphs by PURP Peri-Urban Area (Darkhan, Erdenet, or UB)

Table 31 presents the project impact on herd compositions, as measured by the percent of the herd's total sheep units that are made up of each type of animal. In all three areas, project households increased the representation of improved breed milking cows in their herds, both in an absolute sense and also relative to the comparison households. This is statistically significant in the Erdenet area, and borderline significant in the Darkhan area. In addition, the representation of

goats decreased for project relative to comparison households in Darkhan. None of the other animal types, however, had statistically detectable differences between project and comparison households in any area, though in all three areas the proportion of both goats and sheep in the herd declined for the average Project household, while the proportion of other cattle increased. Since a large focus of the training portion of the project in particular was to switch from traditional livestock to improved breed milking cows, this provides evidence that this aspect of the project was successful even very early on.

Table 31. Project Impact: Change in Herd Composition (Share of Each Animal in Total Sheep Units)

Peri-Urban Area	Type of Animal	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	Improved Breed Milking Cows	9.1	13.4	4.3	2.7	0.08
	Other Cattle	32.0	33.9	1.9	1.0	0.49
	Sheep	24.3	21.8	-2.5	-2.3	0.88
	Horses	14.8	15.0	0.2	-0.4	0.52
	Goats	19.8	15.8	-3.9	-0.9	0.03
Erdenet	Improved Breed Milking Cows	5.9	10.2	4.3	1.2	0.01
	Other Cattle	32.1	32.6	0.5	1.5	0.53
	Sheep	20.1	18.4	-1.7	-2.3	0.56
	Horses	25.4	22.9	-2.6	-0.5	0.06
	Goats	16.4	15.9	-0.5	0.1	0.38
Ulaanbaatar	Improved Breed Milking Cows	6.1	7.0	1.0	-0.2	0.20
	Other Cattle	26.9	28.1	1.2	1.0	0.88
	Sheep	26.1	24.4	-1.7	-1.1	0.50
	Horses	27.2	27.5	0.3	0.2	0.99
	Goats	13.6	13.0	-0.6	0.2	0.31
All Areas	Improved Breed Milking Cows	7.5	10.9	3.4	1.6	0.00
	Other Cattle	30.6	32.0	1.4	1.1	0.74
	Sheep	23.8	21.7	-2.1	-2.0	0.85
	Horses	20.8	20.4	-0.5	-0.2	0.73
	Goats	17.2	15.1	-2.2	-0.4	0.01

Utilization of More Non-forage Animal Feed

The PURP promoted the storage and use of hay and fodder, both to increase animal productivity (especially of milking cows) and to increase herd resilience to severe winter weather, when forage becomes extremely scarce and inaccessible. The project included several trainings on how to grow,

prepare, and use fodder, and also provided alfalfa seeds and fencing materials at subsidized prices to groups that wanted to fence cropping or haymaking areas and grow their own fodder or hay.

Table 32 presents the results of a regression examining the effect of hay and fodder feeding on cow milk production, for project households at the time of the follow-up survey. The results of this regression show clearly the expected relationships. Since a large portion of the project logic of improved income due to milk sales was dependent on higher milk yield from a switch to improved breed milking cows and increased usage of hay and other prepared fodder, these results can be used to justify this link in the context of Mongolian herders. Both improved breed and Mongolian cattle were found to produce similar amounts of milk in the absence of feeding. But improved cattle responded much more strongly to feeding, which can be seen by comparing the interaction terms in the regression, which is nearly twice as large for improved cows. This implies that 100 additional days of feeding would lead to 230 more liters of milk per cow over the year for improved cows, but only 130 more for Mongolian cows. It should be noted that the measure of milk yield used here is calculated by dividing total yearly milk production of the herd by the number of milking cows. Alternative measures of milk yield can also be constructed, which also show the same relationships, but give rise to much larger estimates of yearly milk yield. Given the lack of agreement in the milk yield variables, these numbers should not be interpreted as real milk yield numbers, but only as showing the general relationships between these variables.[44]

Table 32. Effects of Hay Feeding and Cow Breed on Milk Yield

	Total Yearly Milk Yield for Full Herd (p-value)
Number of Improved Breed Milking Cows	187.5
	(.08)
Number of Mongolian Milking Cows	192.7
	(.11)
Interaction: (Improved Cows) x (Days Cattle Fed with Hay or Fodder)	2.300
	(.00)
Interaction: (Mongolian Cows) x (Days Cattle Fed with Hay or Fodder)	1.298
	(.15)
R^2	0.66
N	566

Table 33 presents estimates of the project impact on key variables related to hay and fodder production and usage. In Darkhan area, project households increased their yearly hay and fodder usage (measured by the number of days cows were fed with hay or fodder) by 12 days, while comparison households remained at the same level, and this difference was statistically significant. There was no detectable project effect in the other areas. Darkhan project households also became

[44] It should also be noted that PURLS collected data on the amount of hay purchased and produced by households, but that this variable had no correlation with either the number of days that cows were fed, or with the milk yield, and thus should be considered highly unreliable. Reasons for the unreliability of this variable will be examined further when preparing for any future follow-up surveys.

more likely to gather hay, while comparison households in that areas became less likely, and the difference was statistically significant. In Erdenet, both project and comparison households became *less* likely to gather hay, and there was a statistically detectable negative treatment effect, for which there is currently no good explanation.[45] In contrast, project households in all three areas became more likely to produce fodder crops, and this change was significantly higher than comparison households in all three areas. So it appears that the project was effective in promoting the production of fodder crops, and increased usage of hay and fodder (at least in Darkhan), but had mixed effects on haymaking. As mentioned above, the PURLS variables for total amount of hay produced, purchased, and stored seem to have serious measurement errors and so the outcomes presented are the most meaningful outcomes related to hay and fodder currently available.

Table 33. Project Impact: Hay and Fodder Production and Usage

Peri-Urban Area	Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	Days Cows Fed with Hay/ Fodder	134	146	12	0	0.02
	Gathered Hay (%)	81.4	83.9	2.5	-6.9	0.00
	Grew Fodder Plants (%)	7.0	10.9	3.9	-1.7	0.02
Erdenet	Days Cows Fed with Hay/ Fodder	138	145	7	2	0.39
	Gathered Hay (%)	88.7	76.2	-12.6	-4.6	0.04
	Grew Fodder Plants (%)	7.3	13.9	6.6	-1.2	0.00
Ulaanbaatar	Days Cows Fed with Hay/ Fodder	168	165	-3	-6	0.78
	Gathered Hay (%)	62.4	57.2	-5.2	-7.5	0.63
	Grew Fodder Plants (%)	4.6	14.5	9.8	2.3	0.03
All Areas	Days Cows Fed with Hay/ Fodder	145	151	7	-1	0.02
	Gathered Hay (%)	78	74	-3	-7	0.19
	Grew Fodder Plants (%)	6	13	6	0	0.00

[45] The reduced likelihood of gathering hay could possibly be an artifact of questionnaire design, as the question of whether hay was produced followed a filter question regarding possession of a haymaking area in the follow-up survey, while the restriction of possessing a haymaking area was not imposed in the baseline survey, which perhaps led to depression of the follow-up numbers due to mis-interpretation of the filter question.

b. Long-term Outcome 2: Increased herder group incomes from livestock productivity

Net Earned Income

The main goal of PURP and all MCC projects is to reduce poverty through economic growth. As such the income of the project participants is the most important long-run outcome. MCC has elected to use "net earned income" as the primary income indicator for PURP, and this section analyzes project impact on each component of net earned income in detail.

Figures 14 and 15 present a graphical breakdown of sources of livestock revenues and costs, respectively, for Project households at the time of the follow-up survey. For all three areas, income from selling animals (both live and slaughtered) made up the largest portion of livestock revenue, while income from cow milk sales was second, followed by cashmere. Ulaanbaatar had much lower percentage of revenue generated from selling animals (less than 50 percent), and a corresponding larger share of income from cow milk sales. Darkhan had the opposite pattern, with nearly two-thirds of income from selling animals, followed by cashmere sales, and only 11 percent of revenue from cow milk. Erdenet was in the middle for all three major revenue sources. Livestock-related costs were more similar than revenues across the three areas, with the majority of cost coming from fodder, followed by purchases of livestock and wages for hired herders.

Figure 14. Breakdown of Livestock Revenue at Follow-up, Project Households

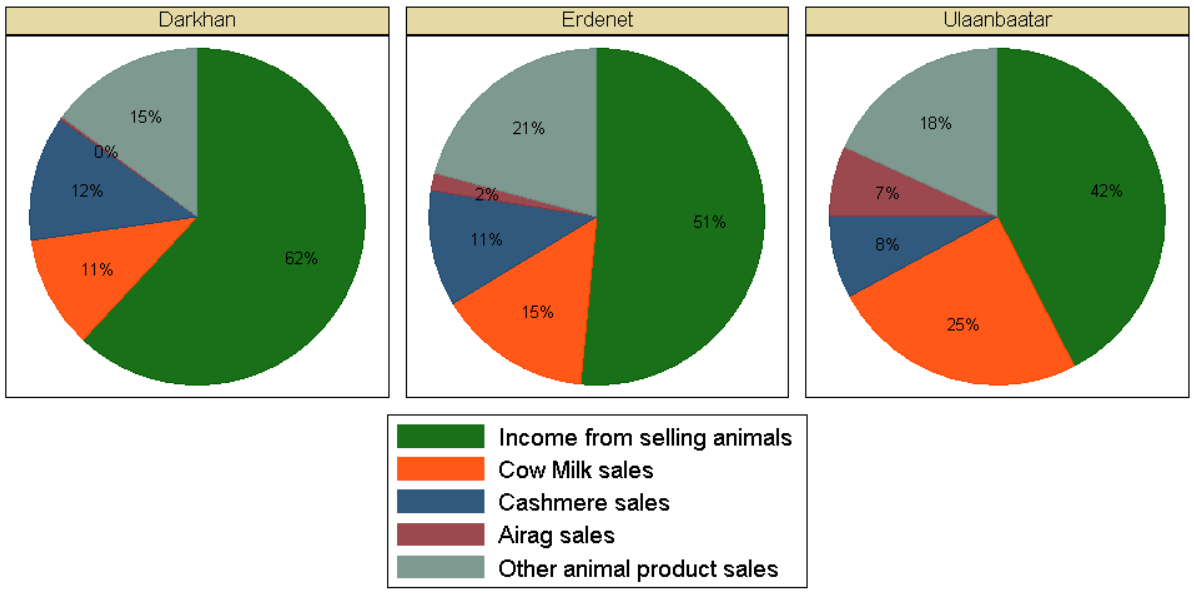
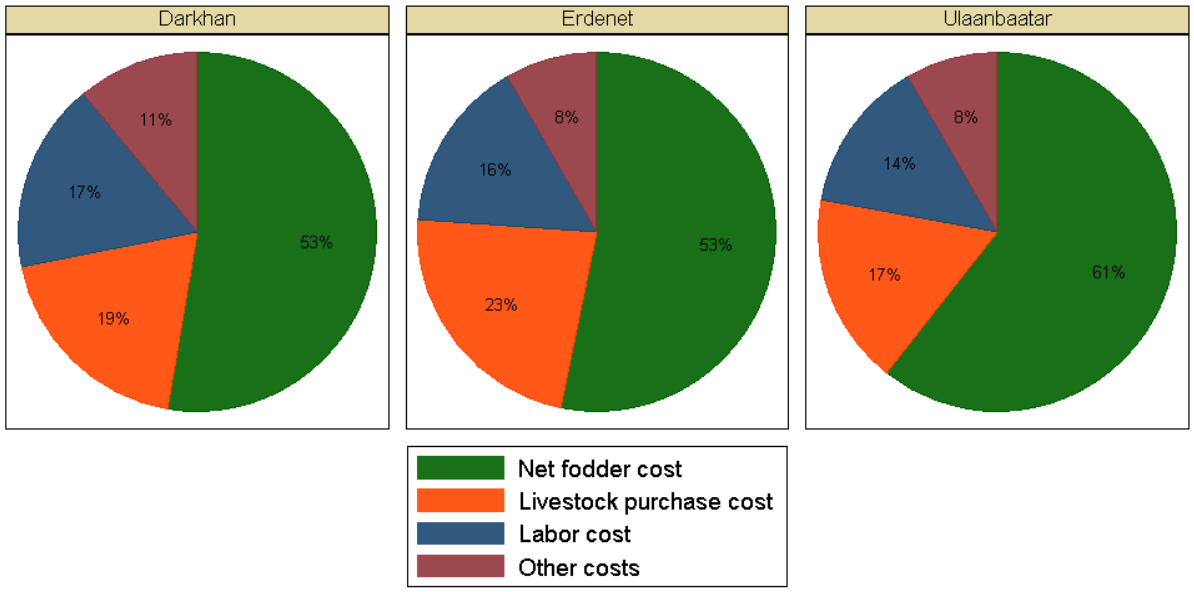


Figure 15. Breakdown of Livestock Costs at Follow-up, Project Households



Graphs by PURP Peri-Urban Area (Darkhan, Erdenet, or UB)

Tables 34 through 36 give a breakdown of the various components that make up net earned income. Cells shaded in grey are included for ease of interpretation, and indicate whether project or comparison households had larger changes for each component.

In the Darkhan peri-urban area, there are no detectable differences in the changes of any of the components of earned income between Project and Comparison households. Project households increase both net livestock income and net earned income by more than Comparison households, but these effects were not statistically significant at conventional levels.

In the Erdenet area, Project households had marginally significant higher increases in costs (by nearly one million MNT, mainly from feed), and higher (though not statistically significant) increases in livestock revenues (mainly from higher sales of animals, which was significant on its own).[46] PURP project implementation unit noted that several groups in the Erdenet area had focused on meat production, so the positive impact on animal sales seen here fits with that observation. These two effects essentially canceled each other out, and there was no significant impact on net livestock revenues, nor in net earned income. Thus in Erdenet area the project herders are using more inputs in their livestock operations, and generating more revenue, but so far no additional profits have resulted from these changes.

[46] It should be noted that animal sales can include both sales of live animals and animals sold for meat, and the distinction was not made in the questionnaires. This distinction will be made in future rounds of PURLS, as it is important to distinguish selloff of animals for reasons of reducing herd size, and sales of animals specifically raised for meat production.

In the Ulaanbaatar area, Project households had significantly higher increase in cost for livestock (mainly from increased use of fodder, but also from purchasing more animals) than Comparison households. Project households also had larger (but not statistically significant) increases in livestock revenue, and a smaller increase in net livestock revenue.

Table 34. Project Impact: Net Earned Income and its Components, Darkhan Peri-Urban Area[1]

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Total earned income	5,566,837	9,140,809	3,573,973	2,979,504	0.57
Non-livestock earned income	1,742,618	2,732,864	990,246	646,397	0.45
Net revenue from livestock	3,824,219	6,407,946	2,583,727	2,333,107	0.76
Total livestock revenue	5,590,360	8,726,957	3,136,597	3,340,515	0.79
Revenue from sales of animals	2,926,811	5,391,351	2,464,540	2,800,712	0.65
Revenue from sales of cow milk	1,203,412	851,565	-351,847	-186,493	0.33
Revenue from sales of other products	1,428,079	2,386,995	958,916	670,348	0.26
Net livestock costs	1,766,141	2,319,011	552,870	1,007,409	0.26
Net fodder costs	926,802	1,219,104	292,302	297,283	0.98
Cost for purchasing livestock	296,670	448,298	151,628	169,054	0.93
Labor cost	309,465	396,140	86,675	70,881	0.77
Other livestock costs	233,204	255,469	22,265	470,190	0.09

[1]Shaded cells indicate which change was larger in magnitude

Table 35. Project Impact: Net Earned Income and its Components, Erdenet Peri-Urban Area[1]

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Total earned income	4,978,711	7,605,810	2,627,099	2,992,618	0.63
Non-livestock earned income	1,591,901	2,302,632	710,732	887,880	0.72
Net revenue from livestock	3,386,811	5,303,178	1,916,367	2,104,737	0.81
Total livestock revenue	5,083,988	8,335,229	3,251,240	2,566,434	0.41
Revenue from sales of animals	2,551,172	4,292,252	1,741,079	702,837	0.05
Revenue from sales of cow milk	1,094,772	1,242,702	147,930	885,835	0.32
Revenue from sales of other products	1,452,545	2,804,735	1,352,190	976,860	0.29
Net livestock costs	1,697,178	3,032,051	1,334,873	461,697	0.07
Net fodder costs	690,372	1,615,228	924,857	125,762	0.01
Cost for purchasing livestock	475,960	691,258	215,298	241,937	0.94
Labor cost	235,232	472,914	237,682	57,705	0.01
Other livestock costs	295,614	252,650	-42,963	36,293	0.35

[1]Shaded cells indicate which change was larger in magnitude

Table 36. Project Impact: Net Earned Income and its Components, Ulaanbaatar Peri-Urban Area[1]

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Total earned income	5,366,295	11,801,038	6,434,744	6,016,810	0.79
Non-livestock earned income	2,131,324	3,287,422	1,156,098	252,204	0.06
Net revenue from livestock	3,234,971	8,513,616	5,278,645	5,764,606	0.74
Total livestock revenue	5,021,800	11,187,068	6,165,267	5,919,585	0.87
Revenue from sales of animals	2,337,890	4,773,491	2,435,601	2,319,320	0.85
Revenue from sales of cow milk	1,439,758	2,762,330	1,322,573	257,467	0.31
Revenue from sales of other products	1,269,004	3,655,431	2,386,427	3,333,620	0.26
Net livestock costs	1,786,829	2,673,451	886,622	154,979	0.00
Net fodder costs	1,166,886	1,618,109	451,224	155,374	0.05
Cost for purchasing livestock	196,358	452,312	255,954	-108,470	0.02
Labor cost	235,324	379,757	144,434	132,004	0.89
Other livestock costs	188,262	223,273	35,011	-23,930	0.12

[1]Shaded cells indicate which change was larger in magnitude

Income from Milk Yields and Related Sales

Tables 37 through 39 give a detailed breakdown of the causal chain leading from a shift in herd composition towards more improved breed cows, increased use of hay and fodder, increased milk yields, and finally improved income from livestock husbandry, which is the key aspect of the project that was to generate increased income, leading to a positive ERR for PURP. Here we examine each step of this chain by peri-urban area, noting deviations from the project logic. [47]

[47] Milk sales reported in these tables differ from those reported in Tables 34-36 because they are based on different questions in the PURLS questionnaire. Those presented above are expected to be more accurate, while those presented here were used because they are more consistent with the other measures in the causal chain. Note that the two measures give quite different estimates, but that for both measures there is no significant project impact for any of the peri-urban areas.

Table 37 examines the Darkhan area. In Darkhan, Project households increased the number of improved breed, but not Mongolian, cattle more than Comparison households, and the percentage of milking cows that were improved breed consequently increased more for Project households. None of these is significant at conventional levels. Project households fed their cattle for 12 more days on average in follow-up than baseline, while there was no change for Comparison households, and the difference was statistically significant. Despite this increase, and the higher proportion of improved breed cows in the herd, yearly milk yield per cow stayed nearly constant for herders in Darkhan area, for both Project and Comparison households. Despite this, the additional cows allowed the Project households to increase both total milk production and the amount of milk sold (in liters), while Comparison households increased total production by a similar amount, yet reduced the amount sold. Milk revenues also slightly increased for Project households, while decreasing for Comparison households. Project impact on amount of milk sold was marginally significant statistically while there was no detectable effect on milk yield per cow or total milk production, or milk sales. The relative increase in amount sold perhaps reflects increased availability of product outlets for Project households in the Darkhan area, though the small difference in the income produced from the additional sales is difficult to explain.

Table 37. Project Impact: Milk Sales, Darkhan Peri-Urban Area

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Number of improved breed milking cows	5.1	6.8	1.7	1.3	0.43
Number of Mongolian milking cows	2.3	2.8	0.5	0.9	0.38
Percent of milking cows that are improved breed	63.3	68.7	5.4	0.9	0.17
Number of days cattle were fed with hay or fodder	134	146	12	0	0.02
Yearly milk yield per milking cow (liters)	637	639	2	0	0.98
Total milk production (liters)	4,028	5,514	1,486	1,424	0.86
Total milk sold (liters)	2,003	2,455	452	-98	0.07
Total milk sales (MNT)	851,961	924,741	72,780	-71,869	0.26

Table 38 examines the Erdenet area. In Erdenet, Project households substantially increased the number of improved breed cows while slightly decreasing the number of Mongolian cattle, while Comparison households slightly increased the numbers of both types of cows. This resulted in a large 14 percentage point increase in the percent of cows that were improved breed for Project households, and nearly no change for Comparison households, and this difference was statistically very strong. Project and Comparison households also slightly increased the number of days that they fed their cattle, but the difference between the two was not statistically significant. Project households increased their yearly milk yield per cow (by nearly 10% for Project households), while milk yield fell for Comparison households, but there was no detectable difference in the change between the two groups. There was a resulting increase in total milk production, amount of milk sold, and revenue from milk sales, for both groups, thought all changes were similar for Project and Comparison households, and were not statistically significant at conventional levels. It is worth noting that although total milk production increased more for Project households, the amount of milk that was sold increased slightly more for Comparison households, which does not have a clear explanation, though the differences were not statistically significant.

Table 38. Project Impact: Milk Sales, Erdenet Peri-Urban Area

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Number of improved breed milking cows	3.8	5.9	2.1	1.5	0.46
Number of Mongolian milking cows	4.7	4.6	-0.2	0.5	0.28
Percent of milking cows that are improved breed	39.6	53.9	14.3	0.6	0.00
Number of days cattle were fed with hay or fodder	138	145	7	2	0.39
Yearly milk yield per milking cow (liters)	443	481	38	-20	0.42
Total milk production (liters)	3,389	4,592	1,202	913	0.58
Total milk sold (liters)	1,757	2,255	498	524	0.96
Total milk sales (MNT)	1,093,544	1,332,521	238,977	240,558	1.00

Table 39 examines the Ulaanbaatar area. In this area, both Project and Comparison households slightly increased the number of both improved breed and Mongolian cows, resulting in a small increase in the percentage of cows that were improved breed for both project households and a small decrease for comparison households, but the difference was not statistically significant. Both Project and Comparison households decreased the number of days that they fed their cattle, by similar amounts. Both Project and Comparison households greatly increased their yearly milk yield per cow (by over 35% for Project households), but there was no detectable difference in the increase between the two groups. There was a resulting increase in total milk production, amount of milk sold, and revenue from milk sales, for both groups, but none of these increases was statistically different between Project and Comparison households. There is no clear explanation for the large increase in milk yields in Ulaanbaatar area compared to the other project areas, particularly given the relatively small changes in herd composition and hay feeding for Ulaanbaatar households. Perhaps more severe exposure to dzud in the baseline period led to depression of milk yields in Ulaanbaatar area more than the other areas, leading to the appearance of a dramatic increase in that area in the follow-up survey. This explanation is supported by the fact that animal mortality rates, which are the most visible result of dzud, were substantially higher in Ulaanbaatar than in the other areas, as can be seen in Figure 16 below. This result makes clear that the dzud was a major factor in a wide range of outcomes in the baseline survey, and thus

observed changes in variables should be interpreted with the understanding that the baseline data was collected during a highly irregular year.

Table 39. Project Impact: Milk Sales, Ulaanbaatar Peri-Urban Area

Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Number of improved breed milking cows	3.2	3.6	0.4	0.7	0.45
Number of Mongolian milking cows	3.9	4.5	0.6	0.8	0.60
Percent of milking cows that are improved breed	36.7	40.9	4.1	-0.5	0.11
Number of days cattle were fed with hay or fodder	168	165	-3	-6	0.78
Yearly milk yield per milking cow (liters)	528	716	188	203	0.79
Total milk production (liters)	3,722	5,438	1,716	2,767	0.11
Total milk sold (liters)	2,452	3,039	586	1,331	0.25
Total milk sales (MNT)	1,423,445	1,619,295	195,850	589,048	0.30

To give a better understanding of the puzzling pattern presented in the preceding three tables examining the determinants of milk sales, Table 40 presents the changes in yearly milk yield per cow using a separate measurement method also contained in the PURLS survey.[48] The same general pattern of no project impact is still present when looking at this variable, and the relative changes between project and comparison households are similar within each area, but the overall milk yield is much higher with this second measure, and the changes within areas are substantially different. In particular, while only Ulaanbaatar area project households saw substantial milk yield increases between baseline and follow-up using the original measure, when using the alternative measure, all areas saw substantial increases, and Ulaanbaatar was the smallest. These facts highlight the unreliability of self-reported milk yield measures and give reason to be cautious when interpreting the results in the preceding paragraphs.

[48] The original measure was based on asking about total milk production in the year and diving by the number of cows. The alternative measure was constructed by asking detailed questions about daily milk yield in different seasons for the highest and lowest producing cows in the herd, and averaging them.

Table 40. Project Impact: Milk Yield per Cow (Alternative Measure)

Peri-Urban Area	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	899	1044	145	134	0.85
Erdenet	604	728	124	68	0.30
Ulaanbaatar	804	863	60	91	0.55

Herd Mortality

Herd mortality is a critically important aspect of herders' lives, particularly during very severe winters (*dzud*). The project intended to help herders become more resilient to extreme weather by the provision of animal shelter materials, as well as the promotion of stored hay and fodder. However, at this time it is difficult to interpret changes in herd mortality using information from PURLS. Because of the short timeframe between the two surveys, weather effects generate too much volatility in the data on herd mortality. In particular, the baseline was conducted after the worst dzud in decades (2009-2010), that had resulted in an unprecedented number of animal deaths. The effects of the dzud on animal death rates can be seen in Figure 16, where it is also clear that the dzud was particularly severe in the Ulaanbaatar area, with over 20 percent mortality of cattle, sheep, and goats, and 14 percent for horses, all of which are at least twice the rates in Darkhan and Erdenet areas, and for horses nearly three times the rates of the other area. The follow-up survey, on the other hand, was conducted during a relatively mild winter, as can be seen in the first column of Table 41. Because the baseline mortality rates were so extreme, the changes from baseline to follow-up do not represent real "changes" in any meaningful sense, so instead of looking at the difference-in-differences, the best option for impact estimation is to compare mortality rates at a single point in time, which can be done in the follow-up survey. The results of the impact evaluation are shown in Table 41. There were significant, statistically detectable differences in mortality rates for sheep and goats in both Erdenet and Ulaanbaatar areas. In all four cases, and especially in Erdenet, the Project households had lower mortality rates than Comparison households. For both types of animals in Erdenet, Project households had less than half the mortality rate of comparison households.

Figure 16. Mortality Rates of Each Animal Type at Baseline

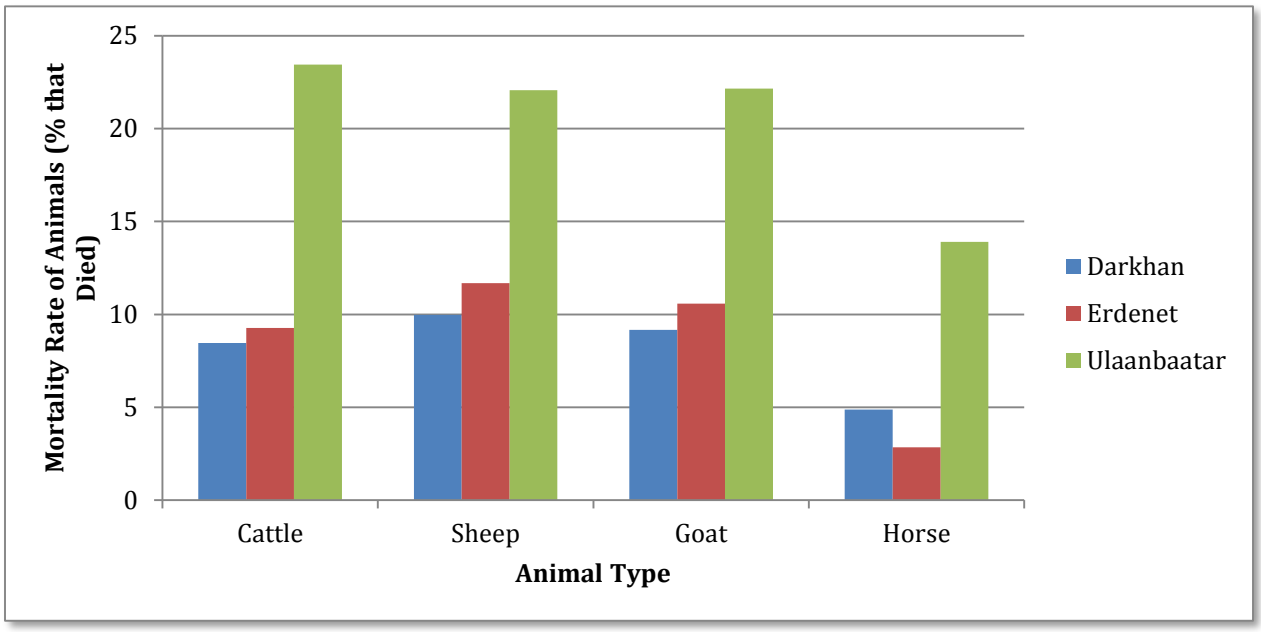


Table 41. Project Impact: Animal Mortality Rates

Peri-Urban Area	Type of Animal	Follow-up: Project Households	Follow-up: Comparison Households (weighted)	Difference: Project - Comparison	P-value: Project - Comparison
Darkhan	Cattle	1.6	1.6	0.0	0.90
	Sheep	2.5	2.6	-0.1	0.89
	Horse	2.7	2.1	0.7	0.37
	Goat	2.2	1.9	0.3	0.63
Erdenet	Cattle	0.8	1.0	-0.2	0.56
	Sheep	1.9	5.2	-3.3	0.05
	Horse	2.9	3.6	-0.6	0.47
	Goat	0.8	4.8	-4.0	0.04
Ulaanbaatar	Cattle	1.4	1.7	-0.3	0.49
	Sheep	0.8	2.4	-1.6	0.00
	Horse	2.2	1.5	0.7	0.18
	Goat	1.1	2.0	-0.9	0.05
All Areas	Cattle	1.4	1.5	-0.1	0.63
	Sheep	1.9	3.2	-1.3	0.03
	Horse	2.6	2.3	0.3	0.49
	Goat	1.6	2.7	-1.1	0.07

c. Summary of Causal Pathway 2

Overall there is little evidence for a project impact on household incomes at the time of the follow-up survey. This holds true when looking at total earned income, as well as all the separate components of income. When taking a closer look at revenues from cow milk sales specifically, there is some evidence of project impact on behavioral change, particularly with a shift in herd composition towards improved breed milking cows for project households in all areas, and slightly increased production and usage of hay and fodder. Although households switched the composition of their cattle herd to more improved breed milking cows, there was little evidence that this shift caused increases in average milk yield per cow. This is difficult to reconcile with the regression results presented in Table 32, which predict higher yields in herds with a larger percentage of improved breed cows, but one possible explanation is that recently purchased improved-breed cows were still young at the time of the survey, and older cows produce more milk. Additionally, at the time of the follow-up survey the behavioral changes did not manifest in increased cow milk sales relative to comparison households. At the time of the follow-up survey, Project households did have notably lower mortality rates of sheep and goats in Erdenet and Ulaanbaatar areas, but this result should be taken with a grain of salt, because no reliable baseline data was available to control for baseline differences in mortality rate.

iii. Causal Pathway 3: Improved Land Tenure Security

The third causal pathway considered is that of improved tenure security from the provision of leases, which should in the long run lead to both increased investment on the land (including investment in immovable property such as housing, building and maintaining animal shelters, and fencing haymaking or cropping areas), and to increased ability to solve pastureland-related conflicts, due to the legal basis of their claim to the land. In many ways this third pathway is complementary to the other pathways, in that land tenure security provides the incentives needed for improved pastureland management outcomes, as well as the long term guarantee of land use rights which promotes investment in hay and fodder production and infrastructure that can support intensive livestock operations, such as indoor shelters. The PURP project logic did not explicitly include the long-term outcomes listed in this section, but they were deemed to be the logical results of a perceived increase in tenure security.

a. Short-term Outcome 3: Increased Land Access & Security from Lease

This outcome should ideally be measured as a perception of land tenure security by those households who gained rights to an area of pastureland through the PURP. However, such perception questions were not asked in the PURLS baseline or follow-up surveys. If future PURLS surveys are fielded, these questions will be added to the questionnaire.

b. Long-term Outcome 3a: Increased Investment in Improvements and Repairs on the Land

Table 42 gives the results of the impact regressions on investment in immovable property, and access to wells. These outcomes were selected over other relevant outcomes such as monetary investment in wells, shelters or fencing, because the structure of the questionnaires did not allow investments due to direct project assistance to be disentangled from investments brought on by choices of the households themselves, and thus were deemed to be unreliable for impact evaluation purposes. Project households significantly increased their investment in immovable property relative to Comparison households in Darkhan and Erdenet areas. In both of these areas, investment was increased by more than 200 percent, while in Ulaanbaatar the increase was nearly 100 percent. In addition, well access at winter camps increased relative to Comparison households in all areas, which is a direct result of the project assistance. On the other hand, well access at summer camps did not significantly increase relative to Comparison households, with the possible exception of Ulaanbaatar area, but this is not surprising since most lease areas were on winter and spring pastures. The increased access to wells at the winter camp is expected because the project provided wells directly to project herder groups. However, the numbers clearly show that many of these herders already had access to wells prior to the project. Nonetheless, access was increased by the project activities.

Table 42. Project Impact: Investment and Infrastructure

Peri-Urban Area	Variable	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	Investment in Immovable Property in Last Year	249,504	1,001,467	751,963	356,907	0.05
	Well access at summer camp	29.8	25.5	-4.3	-6.8	0.63
	Well access at winter camp	62.5	73.7	11.2	-0.4	0.01
Erdenet	Investment in Immovable Property in Last Year	318,139	968,543	650,404	-911,849	0.00
	Well access at summer camp	19.8	23.1	3.3	0.9	0.60
	Well access at winter camp	49.0	65.6	16.6	1.6	0.01
Ulaan-baatar	Investment in Immovable Property in Last Year	1,147,439	2,009,497	862,058	231,392	0.46
	Well access at summer camp	50.5	59.0	8.6	-1.5	0.07
	Well access at winter camp	69.2	89.0	19.8	3.5	0.00
All Areas	Investment in Immovable Property in Last Year	521,600	1,279,657	758,057	6,667	0.02
	Well access at summer camp	32.3	33.9	1.6	-3.0	0.12
	Well access at winter camp	61.0	76.0	15.0	1.2	0.00

c. Long-term Outcome 3b: Reduction in and Improved Ability to Resolve Pastureland-related Conflicts

Table 43 presents the results of project impact regressions on land conflicts. Both baseline and follow-up surveys collected information on the number of pastureland-related conflicts the household had experienced in the previous five years. Very little detail was collected on these conflicts, so the best measure for impact evaluation is simply whether the household had a conflict or not. Note that since both surveys asked about the previous five years, the change we observe is the percent who had a conflict in 2011/2012 and did not have a conflict in 2006/2007, so the numbers should be interpreted with this in mind. Only in the Ulaanbaatar area was there evidence of a project impact on land conflicts (marginally significant), where project households experienced an increase in conflicts while comparison households saw a decrease. This is perhaps not surprising since this area had the highest level of recent in-migration, being around the capital city, and the introduction of a new form of property right is bound to lead to an increase in conflict

with those who are unfamiliar with such a right. Another related explanation is that leases give the herders a sense of ownership over their land that causes them to be more assertive in demanding their exclusive rights, which could result in conflicts.

Table 43. Project Impact: Pastureland Conflicts

Peri-Urban Area	Baseline: Project Households	Follow-up: Project Households	Change: Project Households	Change: Comparison Households (weighted)	P-value: Project Change - Comparison Change
Darkhan	8.4	12.3	3.9	1.7	0.39
Erdenet	6.0	12.6	6.6	8.2	0.63
Ulaanbaatar	8.1	11.6	3.5	-2.1	0.09
All Areas	7.7	12.2	4.4	2.2	0.20

d. Summary of Causal Pathway 3

There is currently limited ability to analyze the third causal pathway due to the absence of tenure security perceptions in the PURLS surveys, absence of detailed questions on pastureland conflicts, and inability to disentangle direct project assistance from other investments decisions. Nonetheless, there is strong evidence that participation in PURP was associated with higher investment in immovable properties, likely because housing construction is expensive and the stability afforded by land rights gave people confidence that they would have access to the same piece of quality pastureland well into the future. Currently there are few studies empirically examining the link between property rights and investment, so this result provides important evidence for the validity of this hypothesized link. In the short run there is no evidence of reduced land conflicts, and in fact conflicts may have increased for project households in the Ulaanbaatar area, perhaps due to the novelty of the new land leasing rights. In the longer term, after the legal basis of the pasture leases is more widely understood, land conflicts are expected to decrease. If this is true, the effect of reduced conflict due to intrusive grazing would also be to facilitate the use of improved pasture management techniques, because herders can be confident that they will reap the benefits of the change.

C. Impact Analysis for Intensive and Semi-intensive Herder Groups

This section presents key results when the impact analysis is conducted separately for intensive and semi-intensive households. In both cases, the full sample of non-project households was used to create a comparison group, just as with the combined analysis presented in Sections VI. A. and VI.B. There was no attempt to identify “intensive” households in the comparison group, beyond the characteristics listed in Appendix B. Overall, the impact analysis did not turn up major differences when separated by intensive and semi-intensive. However, there were some areas where notable difference were found.

For the first causal pathway, while there was no impact found on migration in the combined analysis, in the split analysis we find that intensive households decreased the number of seasonal migrations relative to the comparison group in Erdenet and Ulaanbaatar. Moreover, in Darkhan area, semi-intensive households increased the number of migrations relative to the comparisons.

Thus intensive and semi-intensive households appear to have been affected differently by the project in terms of migration patterns. It was also found that the significantly decreased herd size in Ulaanbaatar was driven mainly by intensive households, while in the Erdenet area there was actually a relative increase in herd size (by 53 sheep units) for semi-intensive households. Finally, all of the improved perceptions of land quality came from semi-intensive households.

For the second causal pathway, a number of differences were found. With regard to herd composition, the percent of cows that were improved breed increased relative to comparison households for semi-intensive households in Ulaanbaatar, while in the combined analysis there was only evidence of project impact in Erdenet area. The portion of sheep units made up of improved breed cows was also found to have increased in both Darkhan and Ulaanbaatar areas, but for intensive households only, while in the combined analysis the only significant effect was in Erdenet. These changes are accompanied by a significant relative fall in the percent of goats in the herd for intensive households in all three areas. These findings together indicate a much stronger and more uniform (across areas) effect on herd composition (specifically, shifting towards improved breed cattle, and away from goats) than suggested by the combined analysis. With regard to hay and fodder production and usage, in addition to the effect seen in the combined sample in Darkhan area, it was also found that semi-intensive households in Erdenet fed their cattle with hay or fodder significantly more days in the year.

For the third causal pathway, no notable differences were found when separating the impact analysis by intensive and semi-intensive.

D. Impact Evaluation Summary

i. Summary of Impact on Short- and Long-term Outcomes

In this section we discuss the results of the project impact evaluation on short- and long-term outcomes. As discussed previously, particularly in Section VI.A, at this stage of the project we expect to observe some changes to short-term outcomes. These short-term outcomes are largely measuring whether herders have adopted improved herd management practices as a result of the training provided. Longer-term outcomes such as improved pastureland quality and increased household incomes were not expected to show up until at least one to two years after the time that the follow-up survey was conducted.

Consistent with this expectation, we observe some short-term impacts, particularly in the second causal pathway discussed in the previous section. There is strong evidence across all areas that project households shifted their herd composition toward more improved-breed cattle. There was also a significant shift of project households beginning to plant fodder crops, and feeding their cattle for more days in the year, relative to the comparison households. There was some evidence that the project increased the likelihood of households gathering their own hay, but this impact was isolated to the Darkhan area. The first causal pathway was mixed in its evidence of project impact on short-term outcomes. In Ulaanbaatar there was evidence that Project households (particularly in intensive groups) were reducing the overall size of their herds relative to comparison households, but the pattern was inconsistent across areas, and there was even a

significant relative increase for semi-intensive households in Erdenet. The other key short-term outcome from the first causal pathway was migration patterns, and while there was some evidence of project impact at the time of the follow-up survey, it differed between intensive (who became more sedentary) and semi-intensive (who increased seasonal migration). Information on short-term impacts for the third causal pathway is lacking, but there was evidence that the project successfully increased access to wells on winter pastures for the project households.

Long-term outcomes showed fewer and less consistent impacts across the three areas. For the first causal pathway, the perception of land quality at the winter camp improved for project relative to comparison households in Darkhan and Ulaanbaatar only, though as discussed above this is a very weak measure of actual land quality, and moreover the effect came entirely from semi-intensive households. Impact on outcomes from the second causal pathway were minimal, with the exception of the intermediate outcome of animal mortality rates, which were significantly lower for sheep and goats in the Erdenet and Ulaanbaatar areas. Apart from this, the strongest effect was to increase fodder costs and overall costs in the Erdenet and Ulaanbaatar areas, which is not an entirely welcome result. However, the increased costs are likely due to a switch to higher-input farming practices which are anticipated to produce long-run returns. There was some evidence of increased income from animal sales in Erdenet, and increased non-livestock earned income in Ulaanbaatar, but these results are isolated and difficult to explain in the framework of the project logic. Moreover, they were not sufficient to increase overall earned income relative to comparison households in either area. Finally, looking at the third causal pathway, we do see a positive project impact on the long-term outcome of investment in immovable property, and also a possible increase in land conflicts for project households in the Ulaanbaatar area. It is likely that the increased land conflicts are a short-term phenomenon, and in the long term we may yet see reductions in land conflicts due to the pasture leases.

ii. Summary of Impact by Peri-Urban Area

At the time of the follow-up survey, trends in project impact were quite different across the three project areas. Each area had a notable project impact in one outcome that made it stand out from the other areas. In the Darkhan area, short-term outcomes of hay and fodder feeding and haymaking improved relative to comparison households, while there was a more limited effect in Erdenet and none in Ulaanbaatar. Moreover, these behavioral changes may have contributed to the slightly higher milk sales in the Darkhan area, which were not evident in the other areas. Given the increased usage of hay and fodder in Darkhan area, it is somewhat surprising that this was this only area where expenditure on fodder did not significantly increase relative to comparison households. In the Erdenet area, Project households had much lower mortality rates for goats and sheep than Comparison households, and although this was also observed in Ulaanbaatar, it was much more pronounced in Erdenet. Erdenet also was the only area that saw a significant relative increase in herd size, which occurred among semi-intensive households. Ulaanbaatar area was the only place where a significant decrease in herd size relative to Comparisons was observed. Apart from these three outcomes, differences between areas generally appear to be quantitative rather than qualitative difference and many of the area-specific impacts seem likely to manifest more broadly in the future after having longer time to play out.

Another interesting area-specific result is the possible, though only marginally statistically significant increase in land conflicts in the Ulaanbaatar area. As discussed previously, this may be only a short-term effect which will reverse in the long run. Moreover, it may have manifested only in Ulaanbaatar because that area had a higher frequency of recent migrants and thus intrusion onto traditional pasture areas was more common. It is also worth noting that Ulaanbaatar was the only area that did not see a project impact on investment in immovable property, and this might be related to the continued conflict that Ulaanbaatar area households continued to experience at the time of the follow-up survey.

There is some evidence that the 2009/10 dzud may have influenced the baseline survey results significantly, and this effect is likely to have been more serious in Ulaanbaatar area, where animal losses were twice as severe as in the other areas. It is difficult using only the available data to discern the impact of the dzud, but in general it seems likely to make absolute changes larger than they might have otherwise been (because of depression of baseline values), and make project impacts less pronounced, because both project and comparison households were both recovering from the same severe weather event, which may make conscious changes in herding practices more difficult. In planning for future evaluations, particularly in areas such as agriculture where weather can play a critical factor, it may be worthwhile to consider baseline data for multiple years prior to a project in order to better understand underlying dynamics, rather than relying on a single snapshot.

VII. Conclusion and Next Steps

As we discuss extensively in Section VI, there is some evidence from the PURLS Phase I follow-up data that herder behavior is changing. Again, this behavioral change is a necessary condition for other more fundamental effects to take place, such as increases in income. The data indicate both positive and negative effects but further analysis is needed to better understand project results. Positive results relative to Comparison households were found in specific areas of interest, particularly a shift in herd composition toward improved breed milking cows, reduced herd size, reduced mortality of sheep and goats, increased likelihood to grow fodder crops, and increased investment in immovable property. The shift toward improved breed cattle and more use of fodder is a crucial short-term behavioral impact that is expected to produce large returns in the form of higher income in the future. Many other variables are showing hints of project impact but at this point the differences do reach conventional levels of statistical significance. The only notable negative result is a possible (and statistically weak) increase in conflicts, which is isolated to Ulaanbaatar area. We want to stress several points for analysis moving forward:

6) External validity may be quite limited because most herders in Mongolia do not live in peri-urban areas, and because the group of herder households who received leases had to pass a stringent set of requirements, in particular with regards to occupying land that was not under conflict. It is unclear how many groups exist that would have similar characteristics. Moreover, there are few “intensive,” western-style dairy operations in Mongolia and many project impacts were strongest for this group. Because the baseline survey collected data from a random sample of herder households in the project areas, an

analysis of the characteristics of project and representative non-project households at baseline is possible, but that analysis has not yet been carried out.

7) The length of time between baseline and follow-up may simply not be long enough to observe changes. It is likely that many of the measures we are studying take much longer to materialize.
8) As we describe above and in the design report, the research design in the Phase I areas of the PURP poses a number of challenges in terms of identifying and attributing project effects. In the Phase II areas, a much stronger design with a randomized controlled trial promises to provide data with which it will be less challenging to uncover project effects.
9) IPA recommends waiting at least three to five years after the end of the compact for an additional round of data collection, which should allow for the best understanding of project impacts, as the effects are likely to continue to grow as time goes on, and the survey attrition rates have been very low. The current plan is to collect a second wave of follow-up household surveys in winter of 2016/17. This plan was decided on in consultation with MCC and after examining the power of the existing sample to detect project effects on a number of outcomes in the future. Details on power calculations are included in Appendix E.
10) For future waves of data collection, numerous changes and additions to the survey instruments will be required in order to more effectively measure changes in all of the key outcomes associated with the project logic. The analysis in Section VI makes clear which questions must be added and improved in order to conduct a more complete and thorough analysis of project impact. Many of the necessary changes have already been incorporated into the PURLS Phase II Follow-up Survey, which was completed in 2014.

VIII. Appendices

Appendix A. Selection Criteria for Candidates

Criteria for Semi-intensive herder groups				
	Criteria	**Documentation**	**Score**	**Relevant documents for scoring**
A	**Minimum criteria:**			
1	Consist of average of 3-6 herder households/farm	Application form	√	
2	Herder members are officially registered at the soum and used pastureland over 180 days permanently in that local area for animal husbandry purpose	Citizen ID and the Bagh governor reference	√	
3	Herder members are agreed not to exceed the carrying capacity of the pastureland. (contract clause)		√	
4	Herder member has animals not over 1000 in sheep units(contract clause)		√	
5	Member of herder group/farm has to be a citizen of Mongolia	Citizen ID and application form	√	
6	At least 60 percent of the member household income has to be from the animal husbandry	Application form	√	
7	All the animals of herder groups/farms have to be healthy	Examination document	√	
B	**Scoring criteria**			
I	**Social-economic criteria (maximum score: 65)**			
1	**Collaboration experience and skill (maximum score: 17)**			
1.1	Experience of selling animal products (milk, meat, animal skin, cashmere etc.) to the market	Application form, knowledge about the local market	3 times in an year = 5 points; Twice in a year= 3 points	Application form, Table 1.3.

1.2	More than half of the herder group members use the pastureland collaboratively	Application form, knowledge about the local market	For whole year = 6 points; 9 months in last year = 4 points; 6 months in last year = 2 points	Application form, Table 1.3.
1.3	Herder group has to have a leader who is been accepted as leader for last 1 year	Application form, knowledge about the local market	2 points	Application form, "Бүлгийн танилцуулга" Table, 9-10-р мөр
1.4	The leader manages the animal husbandry and lives on the potential lease area	Application form, knowledge about the local market	2 points	Application form, Table 1.1, 1.2, 1.5.
1.5	2/3 of the member households are being members in that group for last 3 years	Application form, knowledge about the local market	2 points	Application form, Table 1.1
2	**Animal husbandry managing skill (maximum score: 25)**			
2.1	Percentage of the herder member household income from animal husbandry	Application form, knowledge about the local area	80 or more % = 8 points; 60-80% = 5 points; less than 60 % = 0 points	Application form, Table 1.4.1
2.2	More than half of the herder groups members should have experience of herding milk or meat breeding cow for more than last 3 years	Application form, knowledge about the local area	3 or more years experience = 6 points; 1-3 жилийн туршлага = 4 points	Application form, Table 1.2
2.3	All the member households have traditional animal husbandry experience of herding milk and meat breeding cows	Application form, knowledge about the local area	3 or more years experience = 11 points; 1-3 years of experience= 7 points	Application form, Table 1.2,
3	**Involvement of female headed member households in the group (maximum score: 15)**			

3.1	Percentage of the female headed and low income member households in the group	The income level will be estimated by the method that soum or district uses	More than half of the member households = 15 points; 30-50% = 12 points; 1 household= 8 points	Application form, Table 1.1, 1.4.1, 1.5
4	**Official registration at the local area (maximum score: 8)**			
4.1	Official registration of the herder group members who are over 18 years over at the soum or district	Application form, Citizen ID	All the adult members = 8 points; 70 % of the adult members = 5 points	Application form, Table 1.1, 1.5
II	**Current situation of the animal husbandry (maximum score: 35)**			
5	**Animal productivity (maximum score: 12)**			
5.1	Member households should have pure or cross milk and meat breed cow	Application form, animal census, will be verified at field physically	4 or more = 8 points 2-3 = 6 points; 1 = 4 points	Application form, Table 2.1-ын хагас эрчимжсэн аж ахуйд хамааралтай хэсэг
5.2	average milk yield of the pure and cross breed milking cows	Application form, will be verified at field physically	1000 or more liter = 4 points; 700 or more = 3 points	Application form, Table 2.2.
6	**Experience of supplying milk and meat to the market (maximum score: 8)**			

6.1	Experience of the member households to sell the milked to the market in winter and spring season for last 3 years consistently	Application form, knowledge about the local market, and other related documents	All member households have experience for last 3 years = 4 points; More than 50 % of the member households have experience for last 3 years = 2 points; More than 30 % of the member households have experience for last 3 years = 1 points;	Application form, Table 2.4
6.2	Experience of the member households to sell the meat to the market in winter and spring season for last 3 years consistently	Application form, knowledge about the local market, and other related documents	All member households have experience for last 3 years = 4 points; More than 50 % of the member households have experience for last 3 years = 2 points; More than 30 % of the member households have experience for last 3 years = 1 points;	Application form, Table 2.5
7	**Fodder preparation (maximum score: 4)**			
7.1	More than half of the member households have experience of feeding milking cows and meat breeding cows by fodder for last 3 years	Application form, knowledge about the local market	1 or more month = 4 points; 10 or more days = 2 points; 3 or more days = 1 points	Application form, Table 2.6, 2.7.
8	**Animal shelter /maximum score: 3/**			
8.1	Herder group should have at least one animal shelter for cows	Application form, will be verified at field physically	3 points	Application form, Table 2.8.
9	**Equipment of hay and fodder preparation /maximum score: 2/**			

9.1	Herder group should have machines and equipment to prepare hay and fodder	Application form, will be verified at field physically	2 points	Application form, Table 2.9.
10	**Milk processing equipment /maximum score: 2/**			
10.1	Herder group should have milk processing equipment	Application form, will be verified at field physically	2 points	Application form, Table 2.9.
11	**Winter and spring camp possession /maximum score: 4/**			
11.1	More than half of the members households should have the possession certificate for the winter or spring camp	Certificate	4 points	Application form, Table 2.10.

Criteria for Intensive herder groups				
	Criteria	**Documentation**	**Score**	**Relevant documents for scoring**
A	**Minimum criteria**			
1	Consist of average of 3-6 herder households/farm	Application form	√	
2	Herder members are officially registered at the soum and used pastureland over 180 days permanently in that local area for animal husbandry purpose	Citizen ID and the Bagh governor reference	√	
3	Herder members are agreed not to exceed the carrying capacity of the pastureland. (contract clause)		√	
4	Herder member has animals not over 1000 in sheep units (contract clause)		√	

5	Member of herder group/farm has to be a citizen of Mongolia	Citizen ID and application form	√	
6	At least 60 percent of the member household income has to be from the animal husbandry	Application form	√	
7	All the animals of herder groups/farms have to be healthy	Examination document	√	
B	**Scoring criteria**			
I	**Social-economic criteria (maximum score: 40)**			
1	**Collaboration experience and skill (maximum score: 13)**			
1.1	Experience of selling milk to the market	Application form, knowledge about the local market	3 or more times per year = 4 points; Twice per year= 2 points	Application form, Table 1.3.
1.2	More than half of the herder group members use the pastureland collaboratively	Application form, knowledge about the local market	For whole year = 3 points; 9 months in last year = 2 points; 6 months in last year = 1 points	Application form, Table 1.3.
1.3	Herder group has to have a leader who is been accepted as leader for last 1 year	Application form, knowledge about the local market	2 points	Application form, "Herder group introduction " Table, 9-row10
1.4	The leader manages the animal husbandry and lives on the potential lease area	Application form, knowledge about the local market	2 points	Application form, Table 1.1, 1.2, 1.5.
1.5	2/3 of the member households are being members in that group for last 3 years	Application form, knowledge about the local market	2 points	Application form, Table 1.1
2	**Animal husbandry managing skill (maximum score: 15)**			

2.1	Percentage of the herder member household income from animal husbandry	Application form, knowledge about the local area	80 or more % = 5 points; 60-80% = 3 points; 60-аас доош хувь = 0 points	Application form, Table 1.4.1
2.2	More than half of the herder groups members should have experience of herding milk breeding cow	Application form, knowledge about the local area	5 or more years= 10 points; 3-5 years experience = 7 points; 1-2 years experience = 5 points	Application form, Table 1.2
3	**Involvement of female headed member households in the group (maximum score: 7)**			
3.1	Percentage of the female headed and low income member households in the group	The income level will be estimated by the method that soum or district uses	More than half of the member households = 7 points; 30-50% = 5 points; 1 өрх = 3 points	Application form, Table 1.1, 1.4.1, 1.5
4	**Official registration at the local area (maximum score: 5)**			
4.1	Official registration of the herder group members who are over 18 years over at the soum or district	Application form, Citizen ID	All the adult members = 5 points; 70 % of the adult members = 3 points	Application form, Table 1.1, 1.5
II	**Current situation of the animal husbandry (maximum score: 60)**			
5	**Animal productivity (maximum score: 20)**			
5.1	Member households should have pure or cross (1st or 2nd generation cross) milk breed cow	Application form, animal census, and will be verified at field physically	25 or more numbers of milking cows = 10 points; 20 or more numbers of milking cows = 8 points; 10 or more numbers of milking cows = 6 points; 5 or more numbers	Application form, Table 2.1

			of milking cows = 4 points	
5.2	average milk yield of the pure and cross breed milking cows	Application form, and will be verified at field physically	2000 or more = 5 points; 1000 or more = 3 points	Application form, Table 2.2.
5.3	Member households should have experience of insemination by high productive pure or cross breed bull (or bull which meets the standard requirements) in the last 3 years	Application form, knowledge about the local market	For all the milking cows = 5 points; For 50 % of the milking cows = 3 points	Application form, Table 2.3.
6	**Experience of supplying milk to the market (maximum score: 10)**			
6.1	Experience of the member households to sell the milk to the market in winter and spring season for last 3 years consistently	Application form, knowledge about the local market, and other related documents	All member households have experience for last 3 years = 10 points; More than 50 % of the member households have experience for last 3 years = 8 points; More than 30 % of the member households have experience for last 3 years = 6 points; All member households have experience for last 2 years = 4 points	Application form, Table 2.4
7	**Fodder preparation (maximum score: 8)**			

7.1	More than half of the member households have experience of feeding milking cows by fodder	Application form, knowledge about the local market	5 or more months = 8 points; 3-4 months = 6 points; 1-2 months = 4 points	Application form, Table 2.6, 2.7.
8	**Animal shelter (maximum score: 10)**			
8.1	Herder group should have at least one four walls and roof shelter for cows	Application form, and will be verified at field physically	All households have = 10 points; More than 50% of the households have= 8 points; 30-50% of the households have = 6 points	Application form, Table 2.8.
9	**Equipment of hay and fodder preparation /maximum score: 4/**			
9.1	Herder group should have machines and equipment to prepare hay and fodder	Application form, and will be verified at field physically	4 points	Application form, Table 2.9.
10	**Milk processing equipment /maximum score: 4/**			
10.1	Herder group should have milk processing equipment	Application form, and will be verified at field physically	4 points	Application form, Table 2.9.
11	**Winter and spring camp possession /maximum score: 4/**			
11.1	More than half of the members households should have the possession certificate for the winter or spring camp	Certificate	4 points	Application form, Table 2.10.

Appendix B. Variables Used for Propensity Score Estimation

CONTROLS

soum dummies

DEMOGRAPHICS

Age of household head
Gender of household head
Schooling of household head (years)
Number of HH members over 18
Number of HH members under 18
Any member had past animal husbandry training
Any member had past business training

MIGRATION AND GEOGRAPHY

HH residence in soum 5 years ago
Number of seasonal camps
Household is sedentary all year round
Number of households in hot ail at winter camp
Distance migrated in past year
Distance of winter camp from nearest city
Distance of winter camp from places of milk processing or milk sale
Has possession certificate for spring or winter camps

CAMP INFRASTRUCTURE & ASSETS

Winter camp perceived pasture quality
Dummies for each type of shelter at winter camp
Winter camp has access to powered well
Winter camp has access to hand well
Household lives in a (permanent) house in summer
Household lives in a (permanent) house in winter
Household owns a vehicle (car or truck)
Household owns a motorcycle

ANIMAL HEALTH PROXIES

Household gave any vaccinations to animals
Households treated any animals for parasites
Household has agreement to receive regular vet services

continued on next page

HERD COMPOSITION AND PRODUCTIVITY

Death rates for all animals (Dec 2009 to survey time, dzud year)
Number of each animal at time of baseline
Herd size dummy variables: (>1000)
(500 - 1000)
(250-500)
(125-250)
(<125 omitted)
Has improved breed cow
Milk yield dummy variables: (>1000)
(700-1000)
(450-700)
(0-450)
Number of days cows were fed with hay or fodder
Whether household produced hay themselves

INTERACTIONS WITH OTHER HERDERS

Whether HH had a pastureland-related dispute in past 5 years
Coordination of pasture management with other households, in winter
HH is member of a different herding group, outside PURPer of other type of group
Participated in joint business activities with other HH

INCOME and SALES

Total income (net)
Percent of net income from animal husbandry, dummy variables: (80+%)
60-80%
less than 60% omitted
Household sold horses or not
Household sold cattle or not
Household sold sheep or not
Household sold goats or not
Whether household sold cow milk
Whether household sold cashmere
Whether household sold other products

NOTE: size of leased land was not included in the model because there was no comparable measure for non-PURP households

Appendix C. Tests of PURP Logic and Assumptions

This section is a direct examination of several assumptions (explicit or implicit) of the PURP project logic. Many of the statistics discussed were presented in the body of the report, but here they are used to test how the foundations on which the project and its expected benefits were based, measure up to the reality of the lives of the project beneficiaries. Several assumptions that are required to realize the expected project outcomes are examined in detail in the subsequent sub-sections.

Migration

One might predict that PURP would reduce the number of migrations among project participants and enable herders to stop seasonal migration by supporting intensive farming practices. However, as we reported in Section V.A., 22 percent of intensive and 12 percent of semi-intensive herder households were already sedentary at the time of the baseline survey. Although the project did facilitate the ability to stay sedentary by building wells in winter pastureland, and encouraging expanded usage of hay and fodder to supplement grazing particularly among intensive herding groups, it did not push herders to stay sedentary. In fact, the project encouraged rotational grazing of animals, both seasonal and within-season. Thus the predicted net effect on migration patterns is ambiguous. In fact, the project impact on migration was mixed; intensive households became more sedentary and semi-intensive household increased season migration.

Pasture Load, Carrying Capacity, and Land Degradation

One underlying assumption of the entire PURP was that rangelands in Mongolia, particularly in the peri-urban areas, had been subject to overgrazing in recent years and had become degraded as a result. The PURLS surveys can shed at least some light on whether these two assumptions (overgrazing, and land degradation) were true in the areas around Ulaanbaatar, Darkhan, and Erdenet cities. One way of examining this is to look at the carrying capacity of the lease areas, compared with the actual number of animals (in sheep units) being grazed on those same areas. Table 16, in Section V.B., shows several patterns. First, herder group leaders were very over-optimistic in their estimate of their lease area's carrying capacity at the time of the baseline survey. However, they later adjusted their estimates closer to reality. Second, the average number of animals owned by the groups significantly exceeded both the carrying capacity as estimated by PURP in summer of 2012, and the carrying capacity calculated prior to the project using historical grass yield data. Thus data suggest that significant overgrazing may have been occurring in these areas at the beginning of the project.

There are some caveats to this conclusion, however. First, the method used to measure carrying capacity is sensitive to several factors. Moreover, there seems to be little consensus on what are the best measures of carrying capacity. A single measure of "carrying capacity" for an area over-simplifies the reality of the situation, where the ability of a parcel of land to sustain livestock varies greatly from season-to-season and year-to-year based on weather. However, the original calculation of carrying capacity, based on historical average grass yield data, is less susceptible to this criticism. The second caveat is that the animal numbers that group members reported owning may not accurately reflect the actual number grazing on the lease area–some of their animals may be grazed elsewhere, while other herders outside the group might graze some animals within the lease boundaries. More detailed data on grazing patterns will be collected in the second follow-up

survey in 2017. A parallel study being conducted by USDA on the effect of PURP on pastureland productivity and quality will more directly address the issue of overgrazing in peri-urban areas.

Improved Breed Milking Cows

A critical component of the project is to improve the productivity of milking cows by switching from traditional Mongolian cattle to foreign-breed milking cattle, which give much higher milk yields at the expense of being less hardy and requiring more prepared fodder. However, it is not certain how much more yield the foreign breed cattle will give under the same conditions as Mongolian cattle. This issue was examined in Table 32 in the body of this report, and it was found that foreign breed cattle respond to additional feeding with higher milk production than Mongolian cattle.

Additionally, the PURLS survey collected detailed information on a "high producing" and a "low producing" cows from each household's herd. The "high producing" cows can be compared between Mongolian cows and foreign or crossbreed cows to see if the improved breed cattle are in fact getting higher milk yields per day or per year. This comparison is shown in Table A1. It is clear that the improved breed cows are producing much more milk than the Mongolian cows, primarily because they produce more per day. Caution should be used in interpreting these numbers however, since the survey was not designed to make this type of comparison. Simply comparing the highest-producing cow across herds is not representative of the overall population of Mongolian or improved cows. Nonetheless, the numbers do clearly show that foreign cows are out-producing Mongolian cows.

Table A 1. Comparison of Mongolian and Improved Breed Cows[1]

	Mongolian	Improved Breed	Overall
Daily Milk Yield (liters) in milking season	5.0	7.6	6.5
Number of Days Milked in milking season	132.4	136.5	134.8
Yearly Milk Yield (liters)	807	1,354	1,122

[1]Note: These figures reflect only those of the highest producing cows of households

Further Correlations

This section presents additional correlations that were assumed by the PURP logic. It must be noted that these are simple correlations and do not represent any causal relationship. Figure A1 examines the correlation of land conflict with investment in immovable property, milk yield, and revenue from livestock. Those with a land conflict in the past five years had higher investment in immovable property, higher livestock revenues, and higher milk yield.

Figure A 1. Correlations with Land Conflict

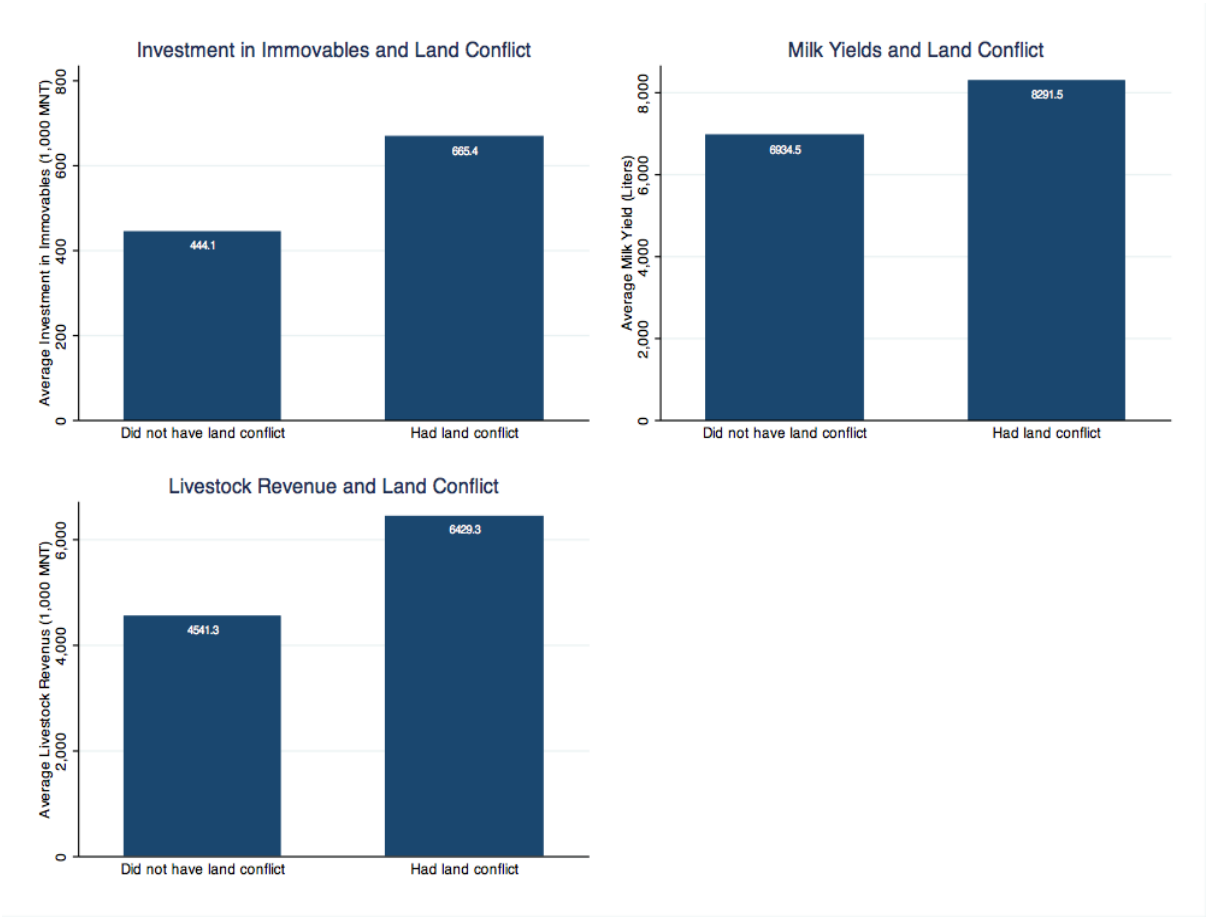


Figure A2 presents the correlations between having a land possession certificate for a winter or spring camp, and investment in immovable property, revenue from livestock and milk yield. All three quantities displayed an association with certificate ownership – those with land certificates had higher milk yields and higher livestock revenue on average. However, surprisingly they also had lower investment in immovable property.

Figure A 2. Correlations with Possession Certificate of Winter or Spring Camp

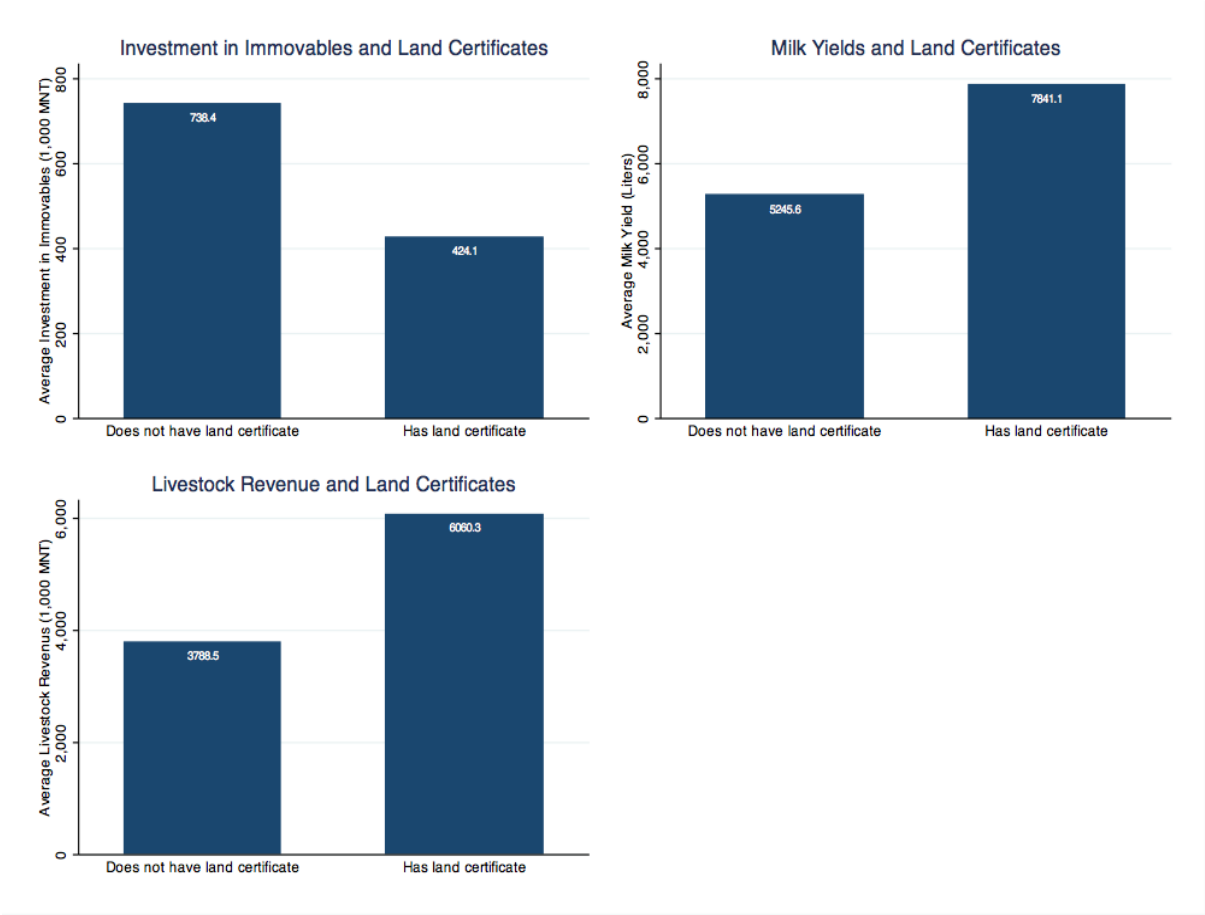


Figure A3 presents correlations between households having prior training in animal husbandry with livestock revenue and milk yield, and between prior business training and livestock revenue. Households with prior training had higher outcomes in all three cases.

Figure A 3. Correlations with Prior Training

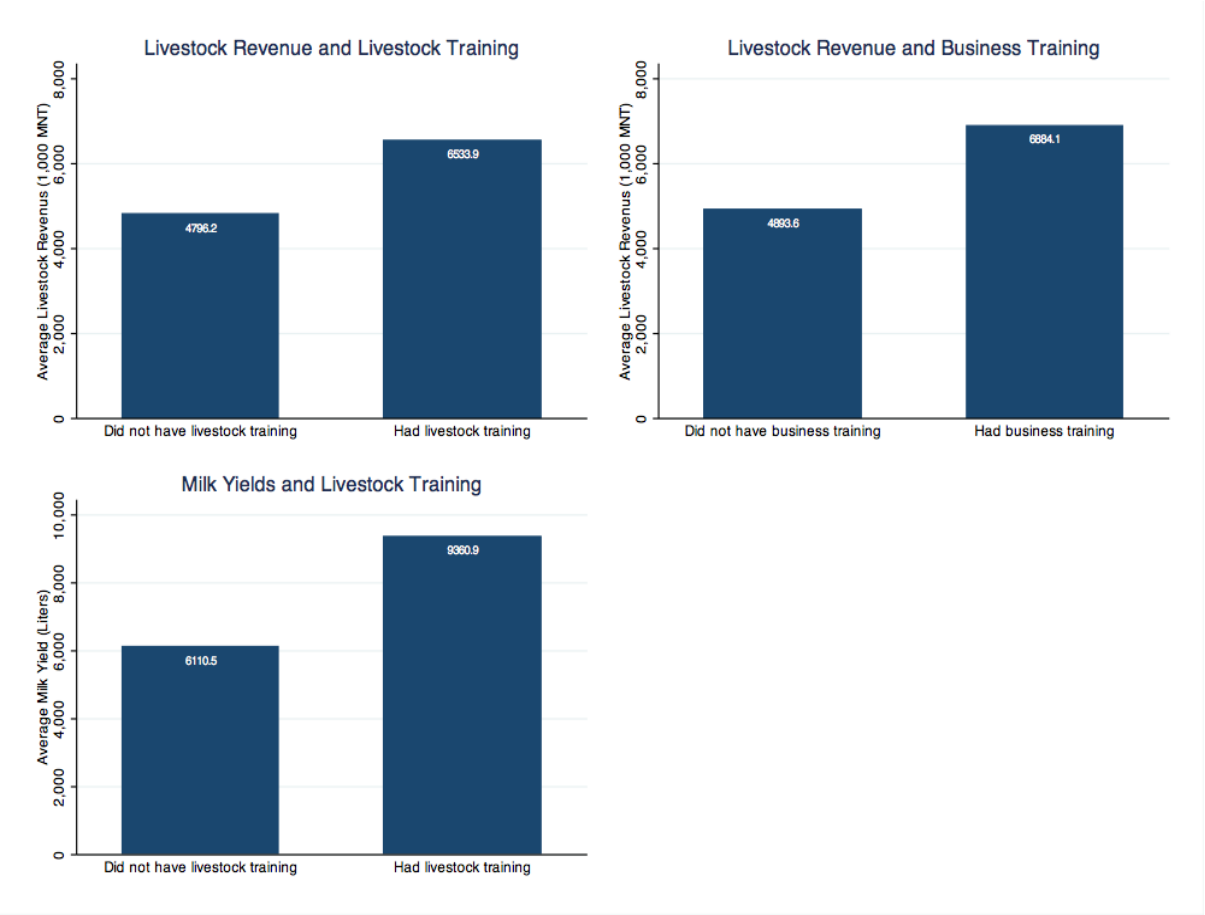
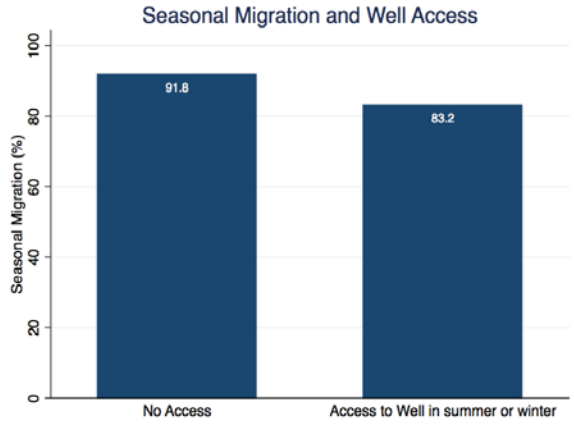


Figure A4 displays the correlation between having access to a well at winter or summer camps, and whether the household migrated at all. Those with access to wells were less likely to migrate (83 percent) than those without access (92 percent).

Figure A 4. Correlation between Well Access and Migration



Appendix D. MCC Indicator Tracking Tables[49]

Indicator	Classification	Unit	Jul 2010 - Sep 2010	Oct 2010 - Dec 2010	Jul 2011 - Sep 2011	Jan 2012 - Mar 2012	Jul 2012 - Sep 2012	Jan 2013 - Mar 2013	Jul 2013 - Sep 2013	Oct 2013 - Dec 2013
Net earned income of herder households in Darkhan, Erdenet and Ulaanbataar (phase I)[50]	Level	MNT	5,388,396				9,452,937			
Net earned income of herder households in Darkhan, Erdenet and Ulaanbataar (male)	Level	MNT	5,647,242				10,100,000			
Net earned income of herder households in Darkhan, Erdenet and Ulaanbataar (female)	Level	MNT	2,495,410				3,677,692			
Net earned income of herder households in Darkhan, Erdenet and Ulaanbataar (Intensive)	Level	MNT	7,349,626				11,900,000			
Net earned income of herder households in Darkhan, Erdenet and Ulaanbataar (Semi-Intensive)	Level	MNT	5,094,212				9,087,435			
Net earned income of herder households in Choibalsan and Kharkorin (phase II)[51]	Level	MNT			3,308,931				4,819,828	
Net earned income of herder households in Choibalsan and Kharkhorin (male)	Level	MNT			3,476,116				5,019,530	
Net earned income of herder households in Choibalsan and Kharkhorin (female)	Level	MNT			1,348,316				2,868,890	
Net earned income of herder households in Choibalsan and Kharkorin (Intensive)	Level	MNT			4,464,665				4,539,843	

[49] All income numbers from PURLS are reported in un-adjusted MNT (Mongolian Tugrug)

[50] Net earned income subtracts out costs, which is one reason the Intensive herders had a lower increase (their costs also increased). Baseline period is Q3 2010 for Phase 1

[51] Baseline period is Q3 2011 for Phase 2

Net earned income of herder households in Choibalsan and Kharkorin (Semi-Intensive)	Level	MNT			3,220,029				4,841,365	
Herd mortality rate in Darkhan, Erdenet, and Ulaanbataar - Cattle[52]	Level	Index	0.13				0.013			
Herd mortality rate in Darkhan, Erdenet, and Ulaanbataar - Sheep	Level	Index	0.141				0.018			
Herd mortality rate in Choibalsan and Kharkorin - Cattle	Level	Index			0.027				0.011	
Herd mortality rate in Choibalsan and Kharkorin - Sheep	Level	Index			0.041				0.024	

Indicator	**Classification**	**Unit**	**Jul 2010 - Sep 2010**	**Oct 2010 - Dec 2010**	**Jul 2011 - Sep 2011**	**Jan 2012 - Mar 2012**	**Jul 2012 - Sep 2012**	**Jan 2013 - Mar 2013**	**Jul 2013 - Sep 2013**	**Oct 2013 - Dec 2013**
Liters of milk per cow in Darkhan, Erdenet, and Ulaanbataar (Phase I)[53]	Level	Liters	808				919			
Liters of milk per cow (Intensive)	Level	Liters	998				1133			
Liters of milk per cow (Semi-Intensive)	Level	Liters	778				886			
Liters of milk per cow in Choibalsan and Kharkorin (Phase II)[54]	Level	Liters			495				720.0	
Liters of milk per cow in Choibalsan and Kharkhorin (Intensive)	Level	Liters			730				875.0	
Liters of milk per cow Choibalsan and Kharkhorin (Semi-Intensive)	Level	Liters			473				706.0	

[52] Phase 1 Baseline mortality was measured during a severe dzud (extremely harsh winter). Livestock mortality rates were extremely high across the country.

[53] Measured as an average of up to five cows in baseline (Phase 1). Measured as an average of up to three cows in interim survey (Phase 1). The specific herders that milked cows was different in baseline and interim surveys, so the milk yield numbers are not exact comparisons across a stable population.

[54] Measured as an average of up to three cows in baseline (Phase 1). Measured as an average of up to two cows in interim survey (Phase 1). The specific herders that milked cows was different in baseline and interim surveys, so the milk yield numbers are not exact comparisons across a stable population.

Percentage of project herder groups limiting their livestock population to the carrying capacity of their leases in Darkhan, Erdenet, and Ulaanbataar (Phase I)	Cumulative	Percentage		39.5				44.4		
Percentage of project herder groups limiting their livestock population to the carrying capacity of their leases in Choibalsan and Kharkhorin (Phase II)	Cumulative	Percentage				55.6				43.8

Appendix E. Power Analysis and Observed Effects

In consultation with MCC, IPA has focused attention for this memo on four key outcomes:

1. **Herd size** (measured in sheep units): Herd size was predicted to decrease for project households relative to comparison households due to the increased incentive to graze sustainably on the exclusive-use leased pasture. This was expected to begin changing almost immediately after the signing of leases, since it is relatively easy for herders to decrease their herd size by selling or slaughtering animals, so we expect to see some project impact on herd size during the interim survey. However, herd size will likely continue to change for several years, with project impact increasing as time goes on.
2. **Cow milk production** (liters/ cow/ year): This is expected to increase significantly after other changes have occurred in animal husbandry practices, especially from increasing the number of foreign breed dairy cows and increased use of hay and other prepared fodder.
3. **Yearly milk sales** (Mongolian Tugrug or MNT): This is expected to increase on a longer time scale, as a result of both increased milk yield and potentially improved marketing skills due to PURP training.
4. **Yearly net earned income** (MNT): Net earned income of herder households is expected to increase in the long run, primarily from increased milk sales and sales of other animal products.

Table 1 shows the results of simulated power calculations for these variables. The minimum detectable effect at power 0.80 and 0.90 is displayed for all four variables. The effect reported is for a difference-in-difference regression, as that is the model that is being used to evaluate project impact. For comparison, the baseline average for the Treatment (project) households, and the actual estimated effect, as reported in the PURLS Phase 1 Interim Report, are also given. The first thing to note should be that of the four outcomes and three peri-urban areas, only one statistically significant effect (at the 0.05 significance level) was found, which is that herd sizes decreased for project households relative to comparison households in Ulaanbaatar. For all other outcomes, a significant impact was not detected. The gray shading in the table indicates where the observed effect exceeded either the .80 or .90 power thresholds, but was not statistically significant. There are three such cases, namely milk yield, herd size, and milk sales, all in Erdenet. Thus power in Erdenet does seem strong enough to capture effects on the magnitude of those observed, though at the time of the interim survey no detectable difference was found.[55]

For the remaining results, it is helpful to consider cross-area comparisons. To understand whether it is reasonable to expect to observe an effect size greater than the MDE in any given area, we look at the largest observed effect across all of the areas. We use this maximum observed effect as a proxy for the "potential project effect" using the logic that what was achieved in one area could be achieved in another.[56] For example, if the observed effect size in Darkhan exceeded the MDE in

[55] Recall that even with power of 0.90, there is a 10% chance that a true effect will be judged "not significant."

[56] An important caveat to this method is that there may be underlying differences in the three peri-urban areas that make the potential effect in one area larger than in the other areas. Nonetheless, without knowledge of these factors, it seems reasonable to view the maximum observed effect as a "potential effect" that might be achievable in any of the areas.

Erdenet, we consider it reasonable to believe that an effect as large as the MDE is achievable in Erdenet, perhaps as more time passes to allow the project effects to unfold. Thus we expect that a follow-up survey several years after the interim survey has a good chance of finding a project impact, even though no significant effect was detected at the time of the interim survey.

For milk yield, the largest estimated effect was in Erdenet, and the study had sufficient power to detect this effect size in all areas. It seems reasonable to assume that the effect observed in Erdenet is potentially achievable in any of the areas, so the power for this variable is high. Note also that milk yield was anticipated to respond fairly slowly to the "treatment" of PURP, as herders will take time to adjust their herd composition and feeding practices. Thus it could be that herders in Erdenet are just adjusting faster than their peers in Darkhan and Ulaanbaatar areas.

A similar pattern is observed for herd size. The observed effect in Ulaanbaatar exceeds the minimum detectable effects in the other areas.

This pattern is not apparent for the remaining variables. For milk sales, we observe effects in Erdenet and especially Ulaanbaatar that exceed the MDE's for Darkhan and Erdenet. Ulaanbaatar has very large MDE (1.7 million MNT, larger than the baseline level), but there is reason to believe that this level is achievable based on the project logic. Consider that the average project household had 38 cattle at baseline. If we use the estimated increase in milk yield per cow in Erdenet, and assume milk price per liter of 1000 MNT for sales, we get (38 cattle) * (56 liters/ yr) * (1000 MNT/ liter) = 2.128 million MNT of potential increased milk sales, which exceeds the MDE in Ulaanbaatar.

Finally for net earned income, the observed effect in all areas is smaller than even the smallest MDE. However, the MDE's for all areas could realistically be achieved. The largest MDE at .80 power is in Ulaanbaatar, and the effect is about 33% of baseline income. This is a large increase, but in absolute terms is not huge – 1.9 million MNT or about $1360.[57] Major shifts in herding practices leading to large increases in milk and meat yields per animal could certainly increase household income by this amount, as was illustrated in the previous paragraph. Note also that MCC's economic rate of return model assumed a difference in yearly income of about $800 by year 6 after the start of the project (when a likely follow-up survey will occur) and $1300 by year 15.[58] These comparisons with ERR must be done carefully, however, as the exchange rate between USD and MNT is quite unstable.

Finally, it is worth noting the substantial and qualitative differences in effect between the peri-urban areas. For all four variables, there were positive and negative observed effects across the three regions, and there is no clear pattern shared by all the variables. This underscores the importance of continuing to separate the analysis by peri-urban area as the evaluation proceeds.

[57] Based on an exchange rate of 1400 MNT/USD in early 2013.

[58] These differences are for semi-intensive herders. Intensive herders were predicted to have increased income due to project participation of $950 and $3250 in years 6 and 15, respectively.

Overall we believe that the evidence suggests that this study is sufficiently powered to detect achievable levels of impact on the key variables that were analyzed, and so there is no basis to cancel the study due to lack of statistical power.

Table 1. Minimum Detectable Effects (MDE) and actual estimates from interim survey

	Milk yield (liters/ cow/ year)			Herd size (sheep units)		
Baseline Treatment Average:	809			463		
	Min. Detectable Effect		**Estimated Effect[2,3]**	**Min. Detectable Effect**		**Estimated Effect**
Power level for MDE[1]:	**0.8**	**0.9**		**0.8**	**0.9**	
Darkhan	51	54	10.7	18	19	-4.7
Erdenet	45	52	55.8	26	29	26.7
Ulaanbaatar	57	62	-31.4	25	27	-48.2*

	Net earned income (MNT)			Yearly milk sales (MNT)		
Baseline Treatment Average:	5,390,000			1,290,000		
	Min. Detectable Effect		**Estimated Effect**	**Min. Detectable Effect**		**Estimated Effect**
Power level for MDE:	**0.8**	**0.9**		**0.8**	**0.9**	
Darkhan	790,000	850,000	594,469	180,000	240,000	-165,354
Erdenet	1,690,000	2,730,000	-365,519	700,000	820,000	-737,905
Ulaanbaatar	1,880,000	2,480,000	417,934	1,760,000	2,320,000	1,065,106

[1]MDE should be compared against the absolute value of the estimate (ignoring the sign).
[2]Estimated difference-in-difference reported in PURLS Phase 1 Interim Report.
[3]Gray shading indicates effects that exceeded one of the power thresholds but was not statistically significant.
* Indicates statistically significant result at the 0.05 level.

Appendix F. Household Questionnaire

[attached separately]

Appendix G. Herder Group Leader Questionnaire

[attached separately]

Appendix H. Soum Governor Questionnaire

[attached separately]

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