

Independent Office
of Evaluation



Georgia Agricultural Support Project

IMPACT EVALUATION



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of Evaluation



Georgia
Agricultural Support Project
Impact evaluation

Photos of activities supported by the Agricultural Support Project in Georgia

Front cover: One of the several irrigation canals rehabilitated by the project. ©IFAD/Agricultural Support Project

Back cover: A juice-producing company, "Gori Baby Feeding Cannery – Kula", which used IFAD's loan to lease a bottling line to bottle juices into cartons. (left). A fruit-grower beneficiary of the irrigation component of the project in the Shida-Kartli region (right).

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Foreword

This report presents the findings of the impact evaluation of the Agricultural Support Project (ASP) in Georgia, undertaken by the Independent Office of Evaluation of IFAD (IOE). The project was implemented between 2010 and 2015 and its main objective was to increase the assets and incomes of the rural poor through commercial agricultural and rural enterprises. As part of its activities, the project provided loans on favourable terms to agro-enterprises for leasing equipment and undertook rehabilitation of small-scale infrastructure such as irrigation schemes, bridges and a drinking water scheme.

The impact evaluation relied on the quasi-experimental approach and combined econometric and qualitative techniques to attribute the impact of the project on its beneficiaries. It deployed two innovative approaches: (1) genetic matching method for matching the treatment group with the comparison group, which gave superior results as compared to the propensity score matching method, and, (2) time-series satellite imagery to compute the normalized difference vegetation index (NDVI) for comparing the change in vegetation cover between treatment group farm plots and comparison group farm plots before and after the rehabilitation of irrigation schemes.

The impact evaluation demonstrated that interventions under the major project component, small-scale infrastructure rehabilitation, did not lead to statistically significant changes in the incomes, assets or food security of beneficiaries as compared to non-beneficiaries. The reasons range from the delayed start of the irrigation scheme rehabilitation to the lack of rehabilitation of all tertiary canals. The results of the minor component, leasing to agro-enterprises, showed positive statistically significant changes in the economic condition of IFAD's intended beneficiaries. The NDVI showed a minor positive change in increased vegetation cover on beneficiary farms.

The assessment of other standard IOE evaluation criteria showed that the project was relevant to the needs of the rural poor and spurred some revitalized interest in agriculture. On the other hand, the project did not achieve the envisioned results for some of the other criteria such as efficiency, effectiveness, gender and natural resource management.

In conclusion, the evaluation argues that to attain measurable changes in the lives of beneficiaries, infrastructure-related projects should go beyond provision of infrastructure and focus also on areas that can hinder development such as extension services and input and output markets. It also argues that when implementing an innovative concept through partners, their appetite for risk should be carefully assessed.

Finally, I am hopeful that the use of innovative approaches in impact evaluations, as was done by IOE in this project, will add value to the evidence on what works and what doesn't in measuring agriculture and rural development results.



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Currency equivalent, weights and measures

Currency equivalent

Currency unit	=	GEL Georgian Lari
US\$1.0	=	1.88 (2010)
		2.32 (2015)

Weights and measures

1 kilogram	=	1000 g
1,000 kg	=	2.204 lb
1 kilometre (km)	=	0.62 mile
1 metre	=	1.09 yards
1 square metre	=	10.76 square feet
1 acre	=	0.405 hectare
1 hectare	=	2.47 acres

Abbreviations and acronyms

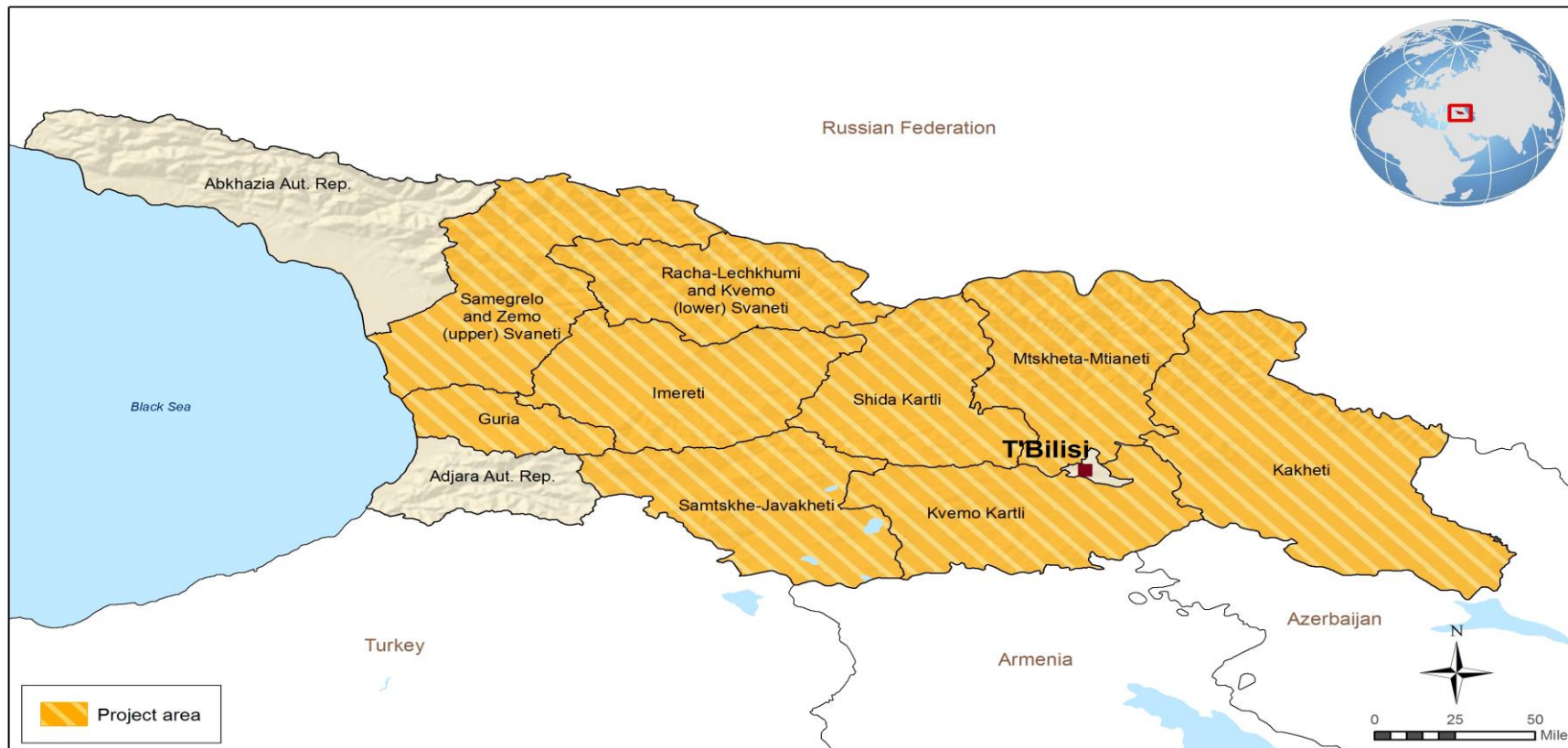
ADPCC	Agricultural Development Projects Coordination Centre
ASP	Agricultural Support Project
BACI	before/after control/impact
CA	control area
COSOP	country strategic opportunities paper/programme (the name changed to country strategic opportunities programme in December 2006)
DID	difference in difference
GILMD	Georgia Irrigation and Land Market Development Project
IFAD	International Fund for Agricultural Development
IOE	Independent Office of Evaluation of IFAD
M&E	monitoring and evaluation
MFI	microfinance institution
NDVI	Normalized Difference Vegetation Index
PFI	participating financial institution
PA	project area
RIMS	Results and Impact Management System (IFAD)
SSRI	small-scale rural infrastructure

Map of the project area

Georgia

Agricultural Support Project

Impact evaluation



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

Map compiled by IFAD | 08-03-2017

Executive summary

Background

1. In line with the decision of the IFAD Executive Board, in 2016/2017 the Independent Office of Evaluation of IFAD (IOE) carried out an impact evaluation of the IFAD-supported Agricultural Support Project (ASP) in Georgia. The overall rationale and terms of reference for this impact evaluation are set out in the associated approach paper.¹

The project

2. The overall goal of the project was to increase incomes among rural people engaged in agricultural activities in Georgia. The project's objectives were: (i) to increase assets and incomes among actually and potentially economically active poor rural women and men willing to move towards commercially viable agricultural and associated rural enterprises; and (ii) to remove infrastructure bottlenecks that inhibit increasing the participation of economically active rural poor in enhanced commercialization of the rural economy (EB 2009/98/R.41/Rev.1, para. 14).
3. **Target group.** Geographically, the project targeted regions with high incidences of poor rural people, combined with areas with high productive potential in agriculture. The target group was composed of agriculture-related producers and processors and rural women and men willing to move towards more commercial production. The rural leasing activities were aimed at commercially-oriented and economically active poor people. Infrastructure rehabilitation was targeted at smallholders with less than one hectare of land. The project had no direct approach to targeting women, but specified a minimum target of 30 per cent women in all categories of project investments.
4. **Project components.** The project had three components: (i) support for rural leasing; (ii) small-scale rural infrastructure (SSRI), consisting of one drinking water system and the rehabilitation of two bridges and six irrigation schemes; and (iii) support to project management and implementation. The first component supported recapitalization of poor smallholders and small and medium-sized agroenterprises. The second component dealt with investments in public infrastructure to enhance the rural population's on-farm and off-farm investments and business activities. The third component provided financial support for the project management unit for implementation activities.
5. **Implementation arrangements.** Under the initial financing agreement, the Agricultural Development Projects Coordination Centre (ADPCC) of the Ministry of Agriculture was expected to assume overall responsibility for day-to-day management of the ASP. However, in February 2011 the ADPCC was liquidated and responsibility for implementation of project activities passed to the Donor Projects Implementation and Monitoring Division within the External Relations Department of the Ministry of Agriculture. In order to ensure continuity, some ADPCC staff were contracted by the Ministry of Agriculture as consultants. The government agency in charge of irrigation – the Amelioration Company – was a partner in the operation and maintenance of the schemes rehabilitated by the project.

Evaluation objectives, methodology and process

6. **Objectives.** The overall goal of the impact evaluation was to assess whether the project was successful or not, and for what reasons, and in doing so to provide policy-relevant information for the design of future IFAD-supported projects. Its main objectives were: (i) to measure and in the process determine whether the interventions had a welfare effect on beneficiaries, and whether this effect could be

¹ See www.ifad.org/documents/10180/5c33014f-7f1e-47a6-aac5-f05fc26b2ede.

attributed to the interventions in question; (ii) to assess the innovative features of the project and provide the information needed to scale up successful project components; and (iii) to provide robust evidence and inputs for the Georgia country strategy and programme evaluation.

7. **Methodology.** The project was evaluated using the criteria provided in the second edition of the IOE Evaluation Manual (2015). These included the four impact domains under the rural poverty impact criterion: (i) household income and assets; (ii) human and social capital and empowerment; (iii) food security and agricultural productivity; and (iv) institutions and policies. In addition, the following criteria were used: relevance, effectiveness, efficiency, sustainability of benefits, gender equality and women's empowerment, innovation and scaling up, environment and natural resources management, adaptation to climate change, overall project achievement along with the performance of partners. The criteria were rated on a scale from 1 to 6, with 6 representing the best and 1 the worst score.
8. The intervention logic of the project (its theory of change) was the point of departure for this impact evaluation (see appendix - annex IV). The impact assessment used a quasi-experimental design in order to attribute the effects observed to the project's interventions. Identification of impact was achieved through a counterfactual – the use of a comparison group. Project effects were calculated principally by use of the difference-in-difference approach. Where it was not possible to use this approach, a single-order difference was calculated (difference between treatment and comparison group at end line only). The baseline values were recreated using recall questions since there were methodological issues with the baseline values collected by the project itself.
9. A mix of quantitative and qualitative tools was used. The core instrument was a household survey, used to collect primary quantitative data. Qualitative tools – such as focus group discussions, key informant interviews and in-depth interviews – provided an understanding of the causal mechanisms through which the project achieved its objectives or failed to do so. An effective sample size of 3,190 households was used to ensure sufficient statistical power.
10. Two approaches were used that were innovative in the context of impact evaluations carried out by IOE. The first was the matching of beneficiaries with comparison group observations, which was carried out using the genetic matching method, as opposed to propensity score matching, in order to obtain better matching. The second was that the use of geospatial analysis, with the Earth Observation methodology, with a focus on the impact of irrigation rehabilitation. The detailed methodology and a discussion of results and lessons learned are presented in appendix - annex VII.

Main evaluation findings

11. **Relevance.** The project's objectives were consistent with national policies, IFAD's strategies and the needs of the rural poor. Similarly, they were also fully compliant with IFAD's corporate Strategic Framework 2016-2025 and with the country strategic opportunities paper (2004).
12. The small-scale infrastructure component was relevant to the needs of the poor, with access to infrastructure considered a key issue faced for the overall development of the rural economy. At the time of project design, the country's irrigation system was in a state of disrepair, with no investments made and no maintenance operations conducted since 1991. Similarly, at the time of design, rural financial operations in the country were generally failing to reach poor rural people. The need for fresh rural financial incentives and greater outreach was to be met through financial leasing. However, the project subcomponents were a discrete set of activities with seemingly little – if any – synergy between them.

13. The project in general targeted those with the capacity to move towards commercialized agriculture. Thus the infrastructure rehabilitation intervention targeted smallholders with less than one hectare of land, as well as woman-headed households. However, it is unclear on what basis the 30 per cent target was set and how this was to be achieved, since no strategy was developed to mainstream gender in the project's targeting approach. The logical framework developed by the project unit lacked the necessary structure and content - no outcomes were listed and no targets were provided against which to monitor outputs and final outcomes. Overall, the impact evaluation rates relevance as moderately satisfactory (4).
14. **Effectiveness.** In terms of project outreach, the project completion report (PCR) reported the SSRI component as having reached a total of 15,790 rural households, out of which irrigation rehabilitation reached 14,450 households and a potential command area of 11,000 hectares. However, these are potential, not actual figures and are based on the assumption that all farms in the command area received irrigation water. In reality, in the 2015 season some 1,420 hectares (13 per cent of the potential command area) had been registered for water supply by the Amelioration Company. This area was brought under irrigated cultivation by approximately 3,390 households (24 per cent of expected beneficiaries). At appraisal, it was expected that approximately 470 direct and 14,200 indirect beneficiaries would be reached through the rural leasing component. At completion, only 15 enterprises had directly participated, together employing 1,152 persons, of which 612 represented an increase on the baseline. Of the estimated 2,645 beneficiaries of backward linkages, only 993 corresponded to an increase. In summary, overall outreach effectiveness was partial in the case of SSRI and fell short for rural leasing.
15. The first objective of the project was linked to the leasing component, which can be judged to have been effective in attracting new investments in rural enterprises. However, the scale was much lower than predicted, and these investments seem to have not created as many new linkages as envisaged, but rather strengthened existing ones. On the other hand, the project's aspiration of introducing rural leasing (group leasing) through microfinance institutions (MFIs) to stimulate investment activity by smallholders was not fulfilled. The project was unable to attract MFIs for several reasons, not least because financial leasing as a financial sector instrument is relatively unknown in Georgia. In addition, the legislation governing MFIs lacked clarity in terms of their role with respect to this instrument. Furthermore, MFIs were expected to pay value added tax (18 per cent) when purchasing equipment (to be refunded later by the Government), thus locking in their funds. Lastly, there were formidable sources of competing interventions, such as rental subsidies on farm equipment through government centres and through programmes of donor agencies that also provided subsidies for the purchase or lease of machinery. A proper business case analysis at project design would have brought these issues to the fore.
16. The two rehabilitated bridges improved access by animals to summer pastures, and the domestic water supply scheme brought piped water to beneficiaries' houses. For the irrigation subcomponent, at project completion less than 15 per cent of the total command area targeted by the project (para. 14) was being cultivated. Uptake of newly available irrigation was slow due to the state of disrepair of the on-farm irrigation schemes, among other reasons. This meant that not all intended beneficiaries would receive water, even if the primary schemes were rehabilitated. Additional factors impeding success were: a lack of access to financial services to fund cultivation and input costs for irrigated planting; an ageing rural population and lack of incentives for youth to return to sub-economic farm units; and migration and incomplete land registration, thereby constraining land consolidation. On the positive side, field visits confirmed improvement in production for some medium to large farms, and some farmers having switched to high-value-added

crops once the irrigation work was completed. However, since in the main the schemes were rehabilitated as late as 2015, it is not possible at this stage to measure the full extent and pace of the intervention. Given the overall performance in relation to the objectives, effectiveness is assessed as moderately unsatisfactory (3).

17. **Efficiency.** The economic and financial return from the project was overestimated in the PCR, given the lower numbers for outreach and the delayed materialization of the expected benefits of the infrastructure component. The economic analysis in the PCR reported an economic internal rate of return (EIRR) of 20 per cent, with a net present value of US\$164 million over a 20-year period. However, assessment of EIRR at project completion is unreliable, due to the absence of quality data on impacts and to unverified assumptions. Additionally, as stated earlier, given that the full irrigation command potential has not yet materialized, the anticipated accrual of benefits will be reduced and delayed. While it has not been possible to assess the impact that this will have on the EIRR, benefits will clearly be less than expected. In the case of the leasing component – which failed to reach certain target beneficiaries – the anticipated benefits have not materialized fully.
18. On the positive side, the cost of project management was just 6 per cent of total disbursements, which is lower than for comparable projects. An analysis of irrigation rehabilitation costs indicated that on average these were 1,980 Georgian lari (GEL) per hectare under the ASP. This is in line with the World Bank's estimated rehabilitation costs of GEL 2,150 per hectare. The period between loan signing and effectiveness was short. However, implementation was delayed by a year due to changes in project management within the Ministry of Agriculture, leading to staff reassignment and recruitment of new staff. Similarly, delays in completion of some irrigation schemes led to a need to extend the loan closing date by one year. Despite the extension, project funds were not fully disbursed, with the overall disbursement rate reaching some 76 per cent of funds committed at project appraisal. Overall efficiency is assessed as moderately unsatisfactory (3).
19. **Rural poverty impact.** The quantitative and qualitative methods deployed to assess the project's impact on rural poverty returned mixed results. They showed no statistically significant changes in agricultural incomes between target and comparison communities in relation to irrigation, bridge and drinking water interventions. However they did show increases in incomes for the farmers who benefited indirectly from the project's lease financing for agroenterprises.
20. Increases in incomes were expected for beneficiaries of the irrigation activities, through increased production and diversification. But a lack of adequate water supply in the main watering season, and the absence of on-farm irrigation (due to the project's main focus on primary and secondary canals) led to planting and production that were less than expected. Switching the crops to be produced, or diversifying the crops, might have led to increased incomes, but this was seen only marginally, if at all. There was an increase in calf numbers due to safer bridges (leading to lower animal mortality), but it was too marginal to have led to increases in incomes for the beneficiary livestock owners.
21. Statistical analysis suggests that the project did not have a significant impact on non-agricultural incomes, as was envisaged in the project logical framework. However, according to project monitoring and evaluation (M&E) data, some employment generation in agroprocessors occurred through leasing. Tests were done to assess whether beneficiary households in the lowest quartile of the income distribution at the start of the project were more likely to move out of poverty. The results showed that the poorest 25 per cent among indirect beneficiaries of the leasing component were likely to have improved their incomes. The same outcomes were observed in the case of physical assets: indirect beneficiaries of the leasing component had increased their assets, but the other beneficiaries had not.

22. The project had little effect on the food security situation of the beneficiaries. Dietary diversity and spending on food, which were used as indicators of food security, showed no statistically significant difference between the beneficiaries and the comparison group. The project showed no significant effect on crop productivity (changes in yields). Similarly, results suggest that in irrigation communities, no additional land was brought under cultivation by the beneficiary households. However, the average size of land under irrigation per household did increase by approximately 0.15 hectares. The geospatial analysis showed an improvement of just 1.24 per cent in vegetation development for treated as compared to control areas. In addition, diversifying from food crops (staples) to high-value-added crops to be grown primarily for markets would have been a sign of commercialization. In this regard, the amount of land dedicated to food crops and to high-value-added crops were tested, but the results showed no significant impact from project activities.
23. The ASP had limited goals in relation to human and social capital and empowerment. In terms of empowerment engendered through a participatory approach, the project consulted with some community members in the design of the project for the bridge intervention, and according to the project, also for the irrigation schemes, although the participants in focus group discussions indicated little if any awareness of consultations. The views of the beneficiaries interviewed were mixed as to whether the project helped reduce water-related conflicts related to drinking water. Some beneficiaries mentioned fewer conflicts, while others indicated no change as compared to before the project intervention. Although it was not an explicit goal of the project, the impact evaluation also checked whether the increase in an improved drinking water source had improved health outcomes. However, no change was observed in the incidence of waterborne diseases.
24. At the project design phase, three primary goals were set out for institutions and policies: (i) consolidation of the ADPCC of the Ministry of Agriculture in its role as the institutional focal point for agricultural development in Georgia; (ii) creation of a leasing sector to promote sustainable rural economic growth and poverty reduction; and (iii) formation of beneficiary groups/organizations. The first goal did not materialize, due to changes undertaken by the Government. The project was unsuccessful in achieving the impact that was meant to come about promoting a pro-poor orientation in private sector organizations, mainly through creation of the leasing sector. The third goal could have been achieved through formation or strengthening of water users' association. However, no increase was noted in membership in water users' associations, with only a few interview respondents reporting being members in 2016.
25. The impact evaluation concludes that the overall rural poverty impact of ASP is moderately unsatisfactory (3). While the project achieved positive outcomes through the leasing activity, no changes were observed for several important outcomes, or outcomes were less than desired. With regard to the irrigation schemes, which was the largest activity in terms of resources allocated, the unsatisfactory results were largely a reflection of late completion of the activity. In addition, the disparate nature of the project's interventions diluted the overall impact of the project.
26. **Sustainability of project benefits.** The infrastructure sustainability risks had been mitigated to some degree by the Amelioration Company and municipalities contributing 5 per cent of total infrastructure costs to a central fund, as an indication of their commitment to the works created under ASP. In that regard, the relevant municipalities had accepted responsibility for the care and maintenance of bridges and the water supply scheme, as had the Amelioration Company for care of the rehabilitated irrigation. The long-term sustainability of infrastructure will, however, depend to a large degree on a sense of common ownership, which has yet to be engendered. The sustained maintenance of irrigation schemes will also

depend on a fair and well organized distribution of water among users, and on efficient on-farm water management.

27. The Government, in collaboration with the World Bank, is introducing institutional reforms within the Amelioration Company to promote water users' participation, which would also improve the sustainability of completed ASP schemes. The success of this however remains to be seen. The sustainability of the leasing component is in a sense secure, as all funds invested were distributed to 15 existing and well-established medium-sized and large private enterprises. Their demand for labour and raw material supplies is also likely to grow, thus sustaining the modest backward linkages developed under ASP. On balance, sustainability is assessed as moderately satisfactory (4).

Other performance criteria

28. **Innovation.** The rural leasing proposal was the most innovative feature of the ASP, and a commendable idea. Carefully and flexibly managed leasing could have offered an option to foster greater inclusion of poorer clients – not least because it removed the collateral constraints of conventional credit. Unfortunately, insufficient business case analysis at the time of design of the MFI-related leasing product, culminated in failure of its implementation – although leasing to agroprocessors was more successful.
29. However, institutional innovations did not come about to promote participation by water users in irrigation scheme design and water management, and nor were measures introduced to improve recovery of water charges. There was virtually no discernible water user participation in the design or management of the scheme, nor a greater sense of system ownership among water users. This evaluation rates innovation as moderately unsatisfactory (3), taking into consideration that while the project's attempt to include innovation as part of its interventions is commendable, it did not work as planned.
30. **Scaling up.** Since only one leasing company and no MFIs were involved in ASP leasing activities, and since all beneficiary lessees were private agroenterprises, at this stage there are no prospects for significant scaling up of rural agricultural leasing. Interviews with TBC Leasing pointed to the likelihood of the company adding rural leasing to its product portfolio, although this cannot be confirmed as a certainty. Furthermore, current legal and regulatory frameworks and tax implications preclude the participation of MFIs – although reportedly some would be interested in adopting leasing instruments if these frameworks were suitably reformed. Since moves on the part of the Government to reform the leasing regulations – making them acceptable to MFIs – were not evident at the time of evaluation, there appears little potential to scale up this activity in Georgia.
31. In contrast, experience in the ASP with irrigation rehabilitation has benefited the design and development of the World Bank-financed Georgia Irrigation and Land Management Development project (GILMD) that was approved in 2015. Some of the institutional and management arrangements tested and implemented through the project's small-scale infrastructure implementation manual have helped establish the operational modalities for the design of the GILMD project. The project's performance with regard to scaling up is assessed as moderately satisfactory (4).
32. **Gender equality and women's empowerment.** Analysis of woman-headed households suggested no significant impact on any of the outcome variables of interest, such as income, food security, moving out of poverty and asset index. Similarly, the results suggested no significant changes in women's role in the decisions about buying assets, deciding which agricultural products are grown/harvested/produced, deciding which agricultural products will be sold or given away, or in how the land will be planted and taken care of.

33. The focus group discussions carried out with women indicated that neither they nor anyone they knew had been consulted regarding project design. The results of project interventions to ease women's work burden through the provision of piped in-house drinking water (thereby reducing their time to fetch water) indicated insignificant time savings. On the other hand, the interviews found that many women in the villages used the piped water for running their washing machines and for other cleaning tasks.
34. The results are a reflection of the fact that although the project adopted a target for the number of women beneficiaries, no modalities were set out for ensuring women's participation and representation in local groups and organizations. Similarly, gender was not considered in the definition of criteria for selecting infrastructure proposals, despite the fact that women in particular might have had an interest in improved infrastructure insofar as it leads to better access to social services and to saving time, thereby helping them reduce domestic and childcare responsibilities. None of the owners of the enterprises were women, although women were employed at some of them. Given the particular context of Georgia, where gender equality and women's empowerment require attention, the project failed to make a notable contribution. The project is rated as unsatisfactory (2) on this criterion.
35. **Environment and natural resources management.** The project's investments in infrastructure did not cause any environmental degradation. Financing of the agriculture sector through the project's rural leasing activities is unlikely to have any negative impact on the environment. However, project design per se appears to have paid little attention to environmental and natural resource management. The cooperation between IFAD and the Amelioration Company could have laid the groundwork for better use of natural resources, especially as related to watershed management. The Government's extension services could have been employed for this purpose. Given that little evidence suggests that this relationship was used to promote environmental and natural resource sustainability, it represents a missed opportunity. Further, the rehabilitation of canals likely reduced the wastage of water, but did not eliminate it: water leakage remained a problem. The project can be considered moderately unsatisfactory (3) in this impact domain. Insufficient focus on the domain represents a missed opportunity.
36. **Adaptation to climate change.** With the country experiencing warmer days and nights, more variable precipitation, and more frequent and intense climate events, there is clearly a need to reduce the risks to Georgian agriculture so as to make the sector more resilient. Adaptation to climate change was not explicitly part of the project design: it did not envision any climate mitigation or adaptation measures. The investments made by the project ensured the rehabilitation of irrigation canals in order to provide water to smallholders, although a more reliable water supply would have ensured better adaptation to the ill effects of climate change. On the other hand, given the variability in precipitation levels experienced by Georgia, one important aspect of adaptation to climate change should have been an emphasis on better management of irrigation water by the beneficiaries. This represents a missed opportunity, especially since an earlier IFAD project – the Rural Development Programme for Mountainous and Highland Areas – had taken adaptation to climate change into consideration in its design. This impact evaluation rates adaptation to climate change as moderately unsatisfactory (3).
37. **Performance of partners: Government.** The Ministry of Agriculture's decision to liquidate the ADPCC, which had responsibility for overall management and implementation of IFAD projects, led to virtual paralysis of project implementation and a difficult transition for the project management unit, due to loss of its earlier autonomy. A number of ADPCC/International Organisation's Projects Implementation Department staff of relevance to ASP management and implementation left the ADPCC. In addition, a considerable delay on the part of the

Government in approving the Rural Leasing Operations Manual further affected all activities planned for 2011. The M&E system was established two years after project start-up. As a result, progress and impact reports were initially not properly prepared, and the lack of a baseline at the start of the project meant that no targets were set within the project logical framework.

38. However, after 2012, with a new national government in place, the performance of the Government and the engagement of the Ministry of Agriculture with the ASP became more consistent. The external audit report to IFAD was submitted on time, and audit work complied with IFAD's Project Audit Guidelines. Similarly, the Ministry of Agriculture took responsibility for managing the M&E system. Consequently, the baseline survey was carried out in 2012 and an end-line survey was carried out at project completion.
39. **IFAD's performance.** IFAD made efforts to actively collaborate with other development partners such as the World Bank, the United States Agency for International Development and Swiss Development Cooperation, to learn from their investments in the agriculture sector in Georgia. On the other hand, the lack of active consultation with donors during the design and in the early stages of implementation meant that the cofinancing envisaged for the project did not materialize, and IFAD had to provide a supplementary loan of US\$5 million to make up the shortfall.
40. In terms of project design, IFAD took the initiative to ensure that responsibilities for infrastructure maintenance were established from the outset. However, the lack of assessment regarding some of the design assumptions may be questioned, in particular the apparently ambitious estimate of the level of participation of both commercial leasing companies and MFIs within the rural leasing component. In addition, the absence at project design of objective specifications of the selection criteria for the leasing proposals led initially to a delay in their approval. This was crucial, since at project design adherence to a strict timeline in processing financing applications from participating financial institutions (PFIs) had been considered to be a paramount for maintaining the interest of PFIs in the ASP.
41. IFAD regularly supervised the ASP, with the supervision reports generally being very informative. Supervision by IFAD facilitated project implementation, through changes in the financial allocations as well as modification of the implementation arrangements and improved specification of the criteria for leasing proposals. The disbursements were generally made on time, and approvals for the annual work plan and budget were given as soon as possible. The evaluation rates both IFAD and government performance as moderately satisfactory (4).

Conclusions

42. The project's premise was correct – that infrastructure bottlenecks were holding back the commercialization of agriculture in Georgia. The project has triggered revitalized interest in agriculture, encouraging other agencies such as the World Bank to scale up neglected irrigation schemes. Similarly, the project's attempt to be novel by introducing a financial product that was innovative within the Georgian context is commendable.
43. However, the project did not achieve the expected impact on its beneficiaries, especially in its biggest component – rehabilitation of the irrigation scheme. Impact analysis showed statistically insignificant results for several key variables of interest. A partially unrealistic design and late implementation in some areas were among the reasons for these results - most irrigation schemes were completed only towards the end of the project, and leasing through MFIs did not occur. However, the indirect beneficiaries of leasing showed an improvement in incomes and assets, and some employment was also generated in the agroenterprises that took up the leasing.

44. The project components were not integrated in a manner that would have produced the expected development results. The disparate nature of interventions, and a visible lack of synergy among them, affected the collective force required for achieving the desired development results.
45. The project's thrust of introducing innovative rural finance services was based on a limited business case analysis, especially for group leasing through MFIs. In addition, project preparation and appraisal failed to consult adequately with partners to determine the constraints and remedies involved in a proposed rural leasing component.
46. The project had a justified concern for backward linkages, but did not back it up with an adequate strategy. There was some mismatch between the targeting strategy for backward linkages and its implementation. For instance, some of the lessees used financing to lease the kind of equipment that had no effect on indirect beneficiaries in the form of increased employment or augmenting supplies from farmers.
47. A big gap in the project was in not synchronizing the rehabilitation of irrigation schemes with the strengthening of the capacity of institutions, improvement of on-farm water distribution, and training support to farmers and their mobilization and organization into informal water users' groups.
48. Women's empowerment was an important but unmet goal, which had been emphasized as a criterion for targeting. The project could have contributed positively towards improving the existing gender imbalance and low level of women's empowerment in Georgia, but was unable to do so because no gender strategy was formulated. However, the project had included the creation of employment for women as one of the terms for providing leasing to agroenterprises.

Recommendations

49. **Recommendation 1. Apply a holistic approach to infrastructure rehabilitation when attempting to achieve a measurable change in the lives of farmers.** At a minimum, providing appropriate support services in agricultural production and marketing should be built into the project design, especially if the aim is to move to commercialization. Similarly, it is recommended to assess the institutional gaps in the particular context when aiming for the long-term sustainability of infrastructure. The lack of harmonization of an infrastructure intervention with the mobilization and organization of beneficiaries into temporary or permanent users' groups can weaken the anticipated longer-term benefits, especially where government departments lack the necessary experience in participatory group formation.
50. **Recommendation 2. A longer-term programmatic approach is necessary for infrastructure-related interventions.** Some project start-up delays after loan effectiveness are inevitable. Within a normal five-year project time frame, substantial infrastructural construction will only be completed during the last two years of the project, leaving little time to identify effects and provide ongoing support services.
51. **Recommendation 3. Minimize the gap between the irrigation potential created and that utilized, by promoting environment and natural resource management.** Providing technical assistance, training and awareness-raising in watershed management to support the capacity needs of those charged with implementing and maintaining irrigation schemes, and those of the beneficiaries, can provide the impetus for a more sustainable use of water.

52. **Recommendation 4. When introducing innovative products in the rural financial space, undertake analysis of both the demand and the supply sides to ensure that new products meet the needs of all concerned.** The project could have acquired a more complete understanding of the requirements, restrictions and guidelines for leasing to MFIs, examining the extent to which they supported the project design. Similarly, for an innovative product, the design should evaluate the partners' risk appetite for taking up an innovative financial offering in rural areas (this being an environment that can be risky for financial products). Finally, estimation of demand for an innovative product should be based on rigorous ex ante analysis and adequate consultations with partners, and even with likely beneficiaries.

IFAD Management's response¹

1. Management welcomes the impact evaluation of the Agricultural Support Project (ASP) in Georgia conducted by the Independent Office of Evaluation of IFAD (IOE). The evaluation has generated interesting lessons that will contribute to the development of the next results-based country strategic opportunities programme (RB-COSOP) and support the ongoing dialogue with the Government on efforts to spur rural economic growth.
2. Overall, Management is pleased to note the evaluation's recognition of the remarkable catalytic role that ASP played in reviving the interest of government and development partners in agriculture. Management also appreciates the commendation of the innovative financial product – rural leasing – introduced by the project. The evaluation confirms that rural leasing contributed to increased incomes and assets of indirect beneficiaries. It also found that the ASP irrigation activities had a significant scaling up effect on the design of subsequent World Bank and IFAD projects.
3. Despite the relevant project design, Management recognizes that some of the project's innovative features, along with implementation lags, shortcomings in the monitoring and evaluation systems, lightly integrated components and, most importantly, the prevailing policy context weakened the overall relevance and effectiveness, which generated mixed performance results. It is worth mentioning that ASP was designed and implemented within a context that at the time was not favourable to agricultural development. Management would like to acknowledge that Georgia has come a long way in its transition in a relatively short span of time. However, Management would like to draw the attention of IOE to a number of factual inconsistencies that were pointed out by the Government and IFAD but are still in the evaluation report. These could be adjusted to better reflect the reality on the ground.
4. Management concurs with the impact evaluation recommendations, which are already being internalized and acted upon under the ongoing Agriculture Modernization, Market Access and Resilience Project (AMMAR) and will inform the new generation of projects. Management's responses to the proposed recommendations are presented below.
 - (a) **Apply a holistic approach to infrastructure rehabilitation when attempting to achieve a measurable change in the lives of farmers. Assess the institutional voids of the particular context when aiming for long-term sustainability of infrastructure.**

Agreed. Management agrees on the validity of this approach, which is the one generally applied in current IFAD investments. However, Management would like to reiterate that the insular approach taken with respect to infrastructure rehabilitation was intentional given the prevailing context at the time of ASP design and implementation. The related project objective aimed to remove infrastructure bottlenecks and a deliberate decision was made to invest in infrastructure as a first measure to reengage in a sector that had at the time been neglected and the need to regain farmers' confidence in appreciating agricultural investments. There is a need to acknowledge that in such situations there is a trade-off between institutional strengthening and establishing credibility among the target groups by delivering the needed resources in a simple and concrete manner. Notwithstanding this, Management acknowledges the forward-looking nature of this recommendation.

¹ The Programme Management Department sent the final Management's response to the Independent Office of Evaluation of IFAD on 1 August 2017.

- (b) **A longer-term programmatic approach is necessary for infrastructure-related interventions.**

Agreed. Management agrees with the recommendation and will apply this to next generation investments, particularly in light of the upcoming RB-COSOP.

- (c) **Minimize the gap between the irrigation potential created and that utilized, by promoting environment and natural resource management.**

Agreed. Management is pleased to inform IOE that it is already pursuing this approach under the ongoing Agriculture Modernization, Market Access and Resilience Project. This project has significant grant financing from the Global Environment Facility aimed at integrating climate-smart agricultural practices and enhancing the adaptive capacity of rural people to deal with climate change and its potential impact on the agricultural sector.

- (d) **When introducing innovative products in the rural financial space, undertake analysis of both the demand and the supply sides to ensure that new products meet the needs of all concerned.**

Agreed. Management agrees with the need to undertake careful analysis, which is normally the case in the context of a full-fledged investment. However, Management cautions against the misplaced assurances such an analysis can generate in the context of introducing innovation. It would be a fundamental misperception to consider that innovation success is assured through ex ante analysis. Innovation needs to be managed through close monitoring and fine-tuning of activities on the ground until they take root.

5. In conclusion, Management thanks IOE for the productive evaluation process and asserts its commitment to internalizing the lessons learned and outcomes of this exercise to further improve the performance of IFAD-funded operations in Georgia and elsewhere.

Fruit plot of a beneficiary of the project's irrigation component in the Shida-Kartli region

©IFAD/Shijie Yang



Georgia

Agricultural Support Project

Impact Evaluation

I. Background, evaluation objectives, methodology and process

1. **Background.** In line with the IFAD Evaluation Policy and as decided by the Executive Board, the Independent Office of Evaluation of IFAD (IOE) undertakes impact evaluations, one every year. In addition to contributing to the repository of impact evaluations, each successive impact evaluation harnesses internal learning by taking cognizance of the experience of its predecessor in its design.¹ In 2016-2017, the office undertook its fourth impact evaluation. The programme selected for the impact evaluation is the Agricultural Support Project (ASP) in Georgia. The project was selected using a comprehensive selectivity framework.²
2. **Objectives.** The overall goal of the impact evaluation for ASP is to assess whether the project worked or not, and for what reasons, and in doing so to provide policy-relevant information for the design of future projects. Its main objectives are:
 - (i) To measure, and in the process, determine whether the project interventions had a welfare effect on individuals, households, and communities, and whether this effect can be attributed to the interventions in question. To this end, an attempt was made to evaluate all effects - positive or negative, direct or indirect, intended or unintended.
 - (ii) To assess the innovative features of the project's design and provide the information needed to scale up successful project components and to inform the design of similar projects in future, thereby strengthening project effectiveness.
 - (iii) To provide useful evidence for and to be used as a critical input in the Georgia country strategy and programme evaluation (CSPE) being currently undertaken by an IOE team.
3. **Process.** The process followed in this impact evaluation is outlined below.

Step 1: The process for undertaking the impact evaluation began with a preliminary assessment of the project (described below).

Step 2: Desk review of project documentation at IFAD headquarters and discussions with the project's country programme manager and (ex) country programme officer in Rome were followed by a scoping mission to Georgia. This entailed meeting with project director and M&E specialist (the same project management unit is involved in a current IFAD project).

Step 3: A competitive bidding process was launched in Georgia to select a company for undertaking the quantitative and qualitative studies for the IOE impact-related criteria, and the Caucasus Research Resource Center, a prominent research agency of Georgia, was selected.

¹ This impact evaluation builds on IOE's previous experience with impact evaluations in Sri Lanka, India and Mozambique.

² Based largely on the selectivity framework, IOE undertakes impact evaluations of projects: (i) within three years of their completion date; (ii) that are not selected for impact evaluation by IFAD Management; (iii) that will also be included as part of the project portfolio analysis in forthcoming CSPEs, to enhance the latter's evidence base; (iv) that have innovative development approaches (e.g. institutional, social, technological) that merit deeper analysis and documentation; and (v) that offer enhanced opportunities for learning, on what works and what does not in promoting sustainable and inclusive rural transformation.

Step 4: Two missions were undertaken by IOE,³ the first for overseeing the pilot testing of the survey and focus group discussion; and the second as the main mission for assessing the results of the main survey, and for collecting information related to other evaluation criteria used in this evaluation.

Step 5: The zero draft of the impact evaluation was internally peer-reviewed by IOE, subsequent to which the first draft will be shared with IFAD and with the Government. All relevant comments were addressed and a final report was prepared. A learning workshop will be held in Tbilisi to discuss the evaluation's main findings and recommendations with key stakeholders and IFAD staff.

4. *Preliminary evaluability assessment of the project.* In addition to the selectivity framework that assists in selecting projects for the impact evaluation, an evaluability assessment was undertaken with the aim to give priority to projects that have an adequate amount of usable self-evaluation data to ensure that impact evaluations by IOE can be done in an effective and efficient manner. Availability of data helps reduce the costs and time taken for IOE to undertake impact evaluations. An evaluability assessment was accordingly undertaken for ASP which showed the following.
5. The project M&E unit had the list of all villages where the project was implemented; list of project beneficiaries was not available since all households in the villages were considered to be targeted (assuming that 80 per cent of all agriculture holdings in Georgia are less than 1 hectare). List of all enterprises targeted was available (leasing component). Results and Impact Management System (RIMS) data were available for all years and for levels 1 (outputs) and 2 (outcome ratings).
6. The project had undertaken both baseline and endline studies. However, since the M&E system was established two years after the project commencement, the baseline was undertaken after project start. The baseline study was conducted in the project treatment area only (sample size of 900 households) and used two-stage stratified cluster sampling. The end-line was conducted using quasi-experimental method with a control/comparison group and using the difference-in-difference method (450 households in the treatment area and 450 households in the control area). Similar to the baseline survey, the end-line survey employed household survey as the data collection tool. Sampling weights were used to ensure representativeness. However, there were several shortcomings observed in the baseline and endline studies by this impact evaluation team. These shortcomings, that are outlined in annex VI helped shape some aspects of the methodology of this evaluation.
7. **Methodology.** The principal aim of this evaluation was to assess the impact of the project on project beneficiaries. Following guidelines of the IOE Evaluation Manual second edition (2015), impact was evaluated using the four impact domains under rural poverty impact criterion: (i) household income and assets; (ii) human and social capital and empowerment; (iii) food security and agricultural productivity; (iv) institutions and policies. In addition, the other criteria evaluated included: relevance, effectiveness, efficiency and sustainability of benefits, gender equality and women's empowerment, innovation and scaling up, environment and natural resources management, adaptation to climate change, overall project achievement and performance of partners (IFAD and Government). In line with the Evaluation Manual, the above criteria were rated on a scale from 1 to 6, with 6 representing the best and 1 the worst score.
8. The **intervention logic** of the project (or, its theory of change) was the point of departure for this impact evaluation (see annex IV). It describes the causal

³ Hansdeep Khaira, lead evaluator for this evaluation, and Shijie Yang, Evaluation Analyst, formed part of both missions whilst Michael Macklin, a rural development expert, participated in the second mission as an international consultant.

pathway from outputs to outcomes (short and medium-long term) and finally to impact. The project log frame (see annex V) formed the basis for the construction of the intervention logic. However, the latter took into account some of the main changes that occurred during the project implementation and therefore, to this extent, it departs from the log frame that was developed at the appraisal stage and which was not modified to reflect the changes as they occurred.

9. The intervention logic shows the causal path for the four main types of interventions that were finally carried out: (i) construction of drinking water scheme; (ii) rehabilitation of bridges; (iii) rehabilitation of irrigation canals and; (iv) rural leasing to agro-enterprises. As an example, financing for leasing was expected to result in increased investment by lessees (agro-enterprises) into machinery or equipment (output) which in turn would lead to increased demand for agricultural/livestock products (as raw materials) from farmers and for labour (immediate outcomes). As depicted in annex IV, the interventions would lead to a set of common outcomes albeit through distinct pathways. The overall impact or the goal of the project was expected to an increase in the general well-being of beneficiaries driven largely by increase in incomes and assets.
10. The following part of the section presents a condensed version of the methodology employed by the evaluation. The detailed methodology is presented in annex VI. The impact evaluation used a mix of both quantitative and qualitative methods in order to utilize the strengths, and overcome the shortcomings, of each of the two (method triangulation). The two methods can be carried out either contemporaneously or sequentially and in the case of this impact evaluation, these were undertaken in parallel, for reasons of cost and time efficiency.
11. The impact assessment used a quasi-experimental design in order to address the issue of endogeneity bias⁴ and to attribute project results to the project interventions. Any identification of impact was achieved through a counterfactual, i.e. what would have happened to the treatment group in the absence of the treatment.
12. The core instrument for the evaluation was the household survey which was used to collect primary quantitative data. The survey was administered to 3,190 households, with 1,778 interviews in control households and 1,412 in treatment households. The quantitative part of the evaluation was complemented by a set of qualitative tools, which provided an understanding of the causal mechanisms by which the intervention either achieved or failed to achieve its goals. Table 1 displays the quantitative and qualitative tools used in the evaluation.

Table 1
Evaluation tools used for the impact evaluation

<i>Quantitative tools</i>	<i>Purpose</i>
Structured impact survey	Administered to all the sampled households for the collection of primary quantitative data.
Focus group discussions	Conducted separately for women and men by project component and sub-component to triangulate with quantitative information.
Key Informant Interviews	Conducted with different project partners to identify project successes and failures particularly as relates to project performance and other performance criteria
In depth interviews	Conducted separately for women and men by project component and sub-component to triangulate with quantitative information.
Normalised Difference Vegetation Index	Conducted using an approach similar to difference in difference method on samples of treated and non-treated areas

⁴ The endogeneity problem arises when there is correlation between the independent variables and the variable of interest i.e. the characteristics that determine selection of individuals into the treatment group also influence the outcomes of interest. This makes the selection into the treatment group a non-random phenomenon.

13. Sample size. Notably, from a statistical perspective, the ASP project activities treated clusters – individuals and households living in a specific area – rather than specific individuals and households. Hence, effective sample size was calculated taking into account the clustered nature of the treatments, rather than performing simple power calculations to determine the number of interviews required to achieve sufficient statistical power. Calculations resulted in effective sample sizes for the 3000 interviews which was considered the maximum possible given budgetary constraints at the outset of the project.⁵
14. Sampling strategy. The evaluation used a multi-stage, matched sampling methodology to identify the individuals to be interviewed for the household survey. First, clusters were sampled. Second, at the village level, random walk with a random starting point was used. Then, in irrigation and leasing communities a screener questionnaire was used. While these overarching strategies were implemented, a number of different strategies were employed in sampling for the different project components, which are described in greater depth below and in annex VI.
15. Using genetic matching with a host of social economic parameters, 27 treatment clusters and 27 control clusters were selected. Within each cluster, a random walk method was used to sample individual household. In order to help address the deficiencies of random walk, random selection of starting points was made from a list of map identifiable points. Regarding sampling for leasing component, due to the absence of a list of indirect beneficiaries (the target population in the leasing component's case), the survey firm reconstructed the supply chains of a number of lessees in the wine industry, within which the sample was drawn. These individuals were identified through random walk and a screening questionnaire to ensure they have supplied grapes to the leasing companies.
16. Interview with respondents were carried out using face-to-face computer assisted personal interviewing (CAPI) on tablet computers. At the end of the interview, the results were sent to a server via mobile internet connection, allowing for fast and high quality data collection, with data entry occurring in real time. Using Google's Open Data Kit software suite, the survey firm Caucasus Research Resource Center -Georgia programmed questionnaires into the tablets.
17. **Quantitative data analysis methods**. The impact evaluation made use of difference in difference (DID) approach. In the present case, this means that incremental changes are measured using an approach where the outcome variable is the reported value of interest for 2016 subtracted from the value for 2012, which is based on recall, for both treatment and non-treatment groups. The resulting values for both the groups are then subtracted from each other to give the final outcome. Given that ASP did not make use of randomization, a two staged matching procedure was used to achieve balance on observable variables. First, treated communities were matched with non-treated communities on a number of variables, as described above. Second, after data collection households were matched using multivariate matching with genetic weights. Finally, when feasible, a differences in differences approach was used, with incremental changes used as an outcome variable rather than only the 2016 outcome. The use of this strategy was expected to increase precision of estimates as well as increase robustness to confoundedness. Regression analyses were then used to estimate causal effects.

⁵ In order to determine whether the above sample sizes would provide the evaluation team with sufficient power to pick up the expected effect size, standard power calculation formula for randomized control trials was used, since previous studies suggest that the statistical power of matching methods is close to that of randomized control trials. Effect sizes of 10 per cent, 20 per cent, and 30 per cent were assumed.

18. For DID analysis, matching of beneficiaries with control observations was carried out as a form of data pre-processing, with several matching options tested.⁶ This evaluation has used the **genetic matching** method for attaining balance on covariates between treatment and control groups. Standard tests performed for both Propensity Score Matching and genetic matching showed that Propensity Score Matching provides worse balance than genetic matching (see annex IX). In addition, genetic matching produced an efficient and least biased estimate with qualitatively better matches i.e. for some key variables of outcome, Propensity Score Matching performed worse than genetic matching.⁷

Box 1:

Genetic matching

- The Genetic Matching (Genmatch) method uses a combination of Propensity Score Matching and Mahalanobis distance methods. It matches samples on their weighted Mahalanobis distances calculated from the distance matrix that includes propensity scores and other functions of the original covariates. Genmatch adopts an iterative approach of automatically checking and improving covariate balance measured by univariate paired t-tests and/or univariate Kolmogorov-Smirnov (KS) tests. In every iteration, weights used in the distance calculation are adjusted to eliminate significant results from the univariate balance tests from the end of the last iteration. The iterative process ends when all univariate balance tests no longer yield progress in increasing p-values. The aim is to maximise the p-value associated with the covariate which represents the greatest difference between the two samples.
- The main advantage of GenMatch is that it directly optimizes covariate balance. This avoids the manual process of checking covariate balance in the matched samples and then re-specifying the propensity score accordingly. By using an automated process to search the data for the best matches, GenMatch is able to obtain better levels of balance without requiring the analyst to correctly specify the propensity score. It makes use of the current advances in computational power.

19. Regressions appropriate to the outcome variable type were then used to estimate causal effects of treatments. Since the independence of observations could not be assumed, clustered standard errors were then calculated. Estimates are reported with the p value which resulted from taking into account clustered standard errors.
20. **Geospatial analysis.** This evaluation also made use of an innovative Earth Observation methodology in supporting the project impact evaluation, with a focus on the impact of irrigation rehabilitation on agricultural production, the second main component of the project. Given that the baseline for this impact evaluation was constructed around the recall method, the use of an additional method would help provide additional basis for the result validation. The methodology was derived from the before/after control/impact (BACI) contrast.⁸ The methodology consisted of a comparative method that analysed the temporal variations (before and after the intervention) of the Normalized Difference Vegetation Index (NDVI)⁹ of the project intervention areas with respect to control sites that were automatically and randomly selected from a set of candidate sites and that were similar to the intervention areas.

⁶ See Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth A. Stuart. "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." *Political Analysis* 15, no. 03 (2007): 199-236. doi:10.1093/pan/mpi013.

⁷ For example, when matching the entire sample, propensity score matching lead to significant differences on the share of ethnic Azerbaijanis as well as whether the household irrigated land or not prior to treatment, a key outcome of interest.

⁸ Presented in the research paper: *Remote sensing monitoring of land restoration interventions in semi-arid environments with a before-after control-impact statistical design*, Meroni et al. 2017.

⁹ Normalized Difference Vegetation Index (NDVI) is an index of plant "greenness" or photosynthetic activity.

21. The rationale is that the project intervention, in terms of increased water availability for irrigation, would cause a different pattern of change in land (vegetation) cover from before to after the intervention in project treatment areas, when compared with similar but non-treated areas for the same period. This concept forms the basis of the BACI sampling design applied in this analysis. The method output is an estimate of the magnitude and significance of the difference in greenness change between the intervention area and control areas. The detailed methodology and a discussion of results and lessons learned are presented in annex VII.
22. **Limitations.** The impact evaluation faced a number of challenges which in turn created limitations for the present study. First and foremost, inaccuracies in the records of location of beneficiaries. This happened to bridge, irrigation, and leasing activities.¹⁰ These issues were only uncovered after survey fieldwork, and thus reduced the sample size of the survey. For example, for the leasing components, since not all companies were willing to provide information about their suppliers, it was only possible to assess the impact on indirect beneficiaries whom sold grapes to a company which was leased to and which the company was willing to provide a list of their suppliers for.
23. Several shortcomings were observed in the baseline and endline surveys undertaken by the project. These shortcomings were:
 - a. The sample size not determined using power calculations;
 - b. The comparison group selected during the endline only.
 - c. The sample sizes for beneficiaries different in the baseline and endline surveys.
 - d. Techniques for matching observables or unobservable characteristics of respondents were not employed.
 - e. Only direct beneficiaries of the leasing component (agro-enterprises) were surveyed; indirect beneficiaries such as those receiving employment, farmers supplying produce to direct beneficiaries, etc., were not surveyed.
 - f. A high level of non-response was noted for important variables such as income (more than 40 per cent).
24. Recall methods were used to recreate the baseline by this impact evaluation. Hence, all impact estimates must be interpreted with the caveat in mind.
25. **Some lessons learned from the methodology.** With regard to methodology for data analysis, although matching in various forms is widely used, the technique also has some limitations. The most obvious is that the pairing of households “with and without” programme can only be done based on observable characteristics. While multivariate matching with genetic weights minimizes bias on observables, it cannot control for unobserved confounding variables.
26. For most forms of quantitative impact evaluation, knowing where beneficiaries are located is critical. The present evaluation lost around 50 observations due to inaccurate lists of beneficiary location and experienced delays due to the lack of knowledge of where indirect beneficiaries are located. Hence, project units are recommended to: a) keep detailed and accurate lists of direct beneficiary communities, and where possible, individuals; b) keep more detailed accounting of indirect beneficiaries when they are the primary target group of a project.
27. Where projects interventions are disparate in terms of their nature and their reach, a decomposition of results into different interventions is a more telling and

¹⁰ One community that was in fact a beneficiary community was not listed for the irrigation sub-component. The direct beneficiary community of a cattle bridge was not listed, and instead a community of indirect beneficiaries was listed. The leasing component list of direct beneficiaries (companies) also included a non-beneficiary.

accurate representation of the project's effects as opposed to the overall project effects. There is also the fact that the average overall effects of the project for some of the main outcome variables can be biased by one intervention alone.

28. Some lessons learned in terms of using *geospatial analysis* are:

- (i) In order to overcome the challenges associated with application of the methodology to a complex environment such as the intensively anthropized irrigated area, a well-designed field visit is essential to explain the confounding factors (e.g. crop rotation, crop change, field context etc.). The use of a structured questionnaire is suggested in order to capture the crop information in the study areas. In the future, it is strongly recommended that the survey firm collect household data with coordinates, which could then be utilised for cross-reference of the NDVI data.
- (ii) Preparation is the key for implementing this kind of methodologies. For example, having accurate maps of command area of canals. This aspect can be improved by holding discussions with project staff to pre-assess the accuracy of treatment area maps.
- (iii) For the selection of control groups, two strategies could be explored: i) using NDVI data as one of the parameters for control group selection in the household survey, and ii) using NDVI data to select a separate control group: such areas could be the ones with potential spill-over effects.

II. The project

A. The context

29. Georgia's economy expanded by 9.6 per cent annually, on average, during 2003–2007, owing to economic and institutional reforms and high foreign direct investment following 2003's Rose Revolution (ADB, 2014). However, the armed conflict with Russia in 2008 brought about the de facto, but not de jure, loss of territory, displaced 200,000 people, and interrupted investment flows. From this, together with the influence of the global financial crisis, GDP growth contracted by 3.8 per cent in 2009. Although it picked up pace from 2010 onwards, the past few years have again seen a dip in economic growth. Georgia's gross domestic product (GDP) per capita rose from US\$916 in 2003 to US\$3,757 in 2015, a reflection of the long term negative population growth rate as well as economic growth. Georgia's growth performance didn't however generate commensurate employment opportunities and the official unemployment rate rose from 11 per cent in 2003 to 16.9 per cent in 2009 (ADB, 2014) with very limited wage growth. Unemployment in 2015 though stands at some 12 per cent.
30. High unemployment further contributed to the weak link between growth and poverty reduction, causing a stagnant poverty status across the country. For example, the percentage of the population living on less than US\$2.00 a day at purchasing power parity decreased only marginally from 36.7 per cent in 2003 to 35.6 per cent in 2010, while the poverty headcount ratio at US\$1.25 a day at purchasing power parity slightly increased from 17.7 per cent to 18.0 per cent over the same period.¹¹ The dichotomy between increasing GDP growth and stagnant poverty reduction can be explained by the low net job creation during growth episodes and the employment limitations imposed by the relatively lower educational attainment of the poor. The Gini coefficient remained high at 0.42 in 2010, reflecting the concentration of income growth in urban areas and among the top 10 per cent of income earners (ADB, 2014). Georgians living in rural areas and engaging in smallholder agriculture have gained little. More than 50 per cent of the population was employed in agriculture (mostly self-employed), which contributed to only 8.4 per cent of GDP.¹²
31. **Agricultural and rural development sector context.** Agriculture remains an important sector in Georgia given that over 50 per cent of the population works in agriculture and contributes about 25 per cent of exports. The dissolution of the Soviet era command economy and privatization of land led to land disaggregation. Georgia's current agriculture has been predominantly subsistence and semi-subsistence production, of which 88 per cent comprised less than 1 hectare and less than 1.5 cows (Design Report).¹³ The agriculture sector is characterized by obsolete and insufficient machinery and equipment; derelict infrastructure; inadequate access to modern inputs; and limited access to markets due to variable quality of outputs and physical communication constraints. Overall, real GDP growth in agriculture during 1997 to 2007 has only been 2.5 per cent. Despite overall fast economic growth, this agriculture stagnation has necessarily impacted upon the rural economy as a whole, reflected in lack of demand for goods and services with a corresponding lack of diversification.
32. The urgent need to address these various problems provided the rationale for IFAD involvement in development assistance to Georgia. The relevant Government policy

¹¹ Sources: ADB; International Monetary Fund; Ministry of Environment and Natural Resources Protection of Georgia; Ministry of Finance of Georgia; National Bank of Georgia; National Statistics Office of Georgia; United Nations Development Programme. 2013; *Georgia Poverty Assessment*. Washington, DC; World Bank. 2011. *Georgia: Poverty Dynamics since the Rose Revolution*. Washington, DC; and World Bank. World Development Indicators Online. <http://data.worldbank.org/country/georgia>.

¹² http://geostat.ge/index.php?action=page&p_id=428&lang=eng.

¹³ According to the most recent agricultural census, over three quarters (77 per cent) of farmers own one hectare or less of land (Geostat, 2014).

context for such assistance is laid out in the 2003-2015 Economic Development and Poverty Reduction Programme of Georgia (EDPRP) and the Ministry of Agriculture's 2009-2011 Agricultural Development Strategy (ADS).

33. *Rural leasing sector.* Financial leasing in Georgia started in 2001. By the time the project was designed, the industry was still young and relatively small, with the total outstanding portfolio of around US\$38 million, mainly operated by three main banks. Financial leasing as a financial sector instrument was relatively little known in Georgia.¹⁴ Financial leasing arrangements require an appropriate legal environment to operate effectively and to grow in importance as an alternative financing instrument. At the project design stage, the legal environment for financial leasing in Georgia was defined as adequate but not perfect, particularly due to the concerns on the value added tax (VAT) in leasing contracts of both the leasing companies and MFIs (WP1 in Design Report, para.39).
34. The lack of appropriate agriculture-related machinery and processing equipment is an important obstacle to agricultural productivity and rural growth. In order to secure that the growth and modernization targets are achieved, Government recognized that it would be necessary to introduce significant changes in mechanisms for financing agriculture, particularly a sharp increase in credit provision through new, innovative methods.
35. *Irrigation system:* In 1988 around 386,000 ha were under irrigation. In 2005-2008 the area irrigated declined to be about 110,000 ha¹⁵ (Design report, para.49). The unstable domestic environment, war, vandalism and theft, transition to a market economy and the loss of markets with traditional trading partners, all contributed to a decline of the irrigated and drained areas. Lack of maintenance and institutional weakness led to severe deterioration of irrigation infrastructure. Moreover, since most irrigation schemes served command areas covering one or more large-scale state farms, land privatization and resultant small plots coupled with high energy consumption of the old system made them inappropriate for the new farm structure and production system (Design report, WP2).
36. **Project objectives.** The **overall goal** of the project was to increase incomes among rural people engaged in agricultural activities in Georgia. The project's **objectives** were: (i) to increase assets and incomes among actually and potentially economically active poor rural women and men willing to move towards commercially viable agricultural and associated rural enterprises; and (ii) to remove infrastructure bottlenecks that inhibit increasing the participation of economically active rural poor in enhanced commercialization of the rural economy (EB 2009/98/R.41/Rev.1, para.14).
37. **Project components.** The project had three components: (1) support for rural leasing; (2) small-scale rural infrastructure (drinking water system, bridges and irrigation canals rehabilitation) and; (3) financing was also provided to support project management and implementation.
38. *Component 1: Rural leasing.* The Rural Leasing component included two sub-components; (i) capital to refinance leasing contracts of participating financial institutions (PFIs) and (ii) international technical assistance, trainings and exchange visits. The component aimed at recapitalization through financial leasing and consequent modernization of Georgian agriculture, specifically among poor smallholders, small and medium sized agro-related enterprises.
39. *Component 2: Small-scale rural infrastructure.* Through the component, ASP was expected to award competitive contributory grants for investments in public infrastructure that would enable and enhance the rural population's investments and activities in on-farm and off-farm related business. Eligible investments were

¹⁴ Georgian Leasing Company, TBC Leasing, and Alliance Group Leasing.

¹⁵ 100,000 ha area by gravity irrigation and 10,000 by pumping station irrigation.

- expected to include: (i) rural roads; (ii) bridges; (iii) community water supply; (iv) community natural gas supply; and (v) small scale irrigation schemes.
40. *Component 3: Project management.* The third component consisted of financial support to the project management unit to look after the day-to-day activities related to project implementation.
 41. **Project area.** Georgia has 71 municipalities which are *de facto* under central Government control. The ASP project was originally planned to be carried out throughout the country, however, during the Supplementary Financing Design Mission in 2012, it was agreed to consider future infrastructure proposals in only four targeted regions: Mtsheta-Mtianeti, Shida Kartli, Samtskhe-Javakheti and Kakheti in order to have the project implemented in a contiguous manner, rather than to disperse rehabilitation activities in unconnected areas. The poverty rate in these regions was also among the highest in Georgia with Shida Kartli at 51 per cent Mtskheta-Mtianeti at 49.3 per cent Kakheti at 35.3 per cent, and Samtskhe-Javakheti at 17.6 per cent according to 2.5/day poverty headcount.¹⁶ They are mostly in the mountainous area with short agricultural season (FAO).¹⁷
 42. These regions were also selected given their concentration of Internally Displaced Persons from the 2008 conflict with Russia as well as high concentration of ethnic minorities, both of whom are socially and economically disadvantaged groups in Georgia. Project activities ultimately had direct beneficiaries in 13 municipalities across nine regions in Georgia (Government PCR, p. 4).
 43. **Target population.** At design the targeting strategy of the project was that it would cover all of rural Georgia but with special emphasis on regions with high incidences of poor rural people combined with areas with a high productive potential in agriculture, including those affected by the 2008 conflict with Russia. In terms of its target groups, the project was expected to target agriculture-related producers and processors, particularly poor rural women and men, willing to move towards more commercial production. The rural leasing activities were supposed to outreach to **commercially-oriented and economically active poor**, with an upper limit for leasing companies of US\$300,000 per client and for microfinance institution up to US\$30,000. Infrastructure rehabilitation projects were targeting smallholders with less than one hectare of land.
 44. More specifically, the infrastructure component was initially designed to target "farmers' interest groups, formal producers' associations, and local small and medium size entrepreneurs/processors". They would have opportunity to further improve their circumstances, either through capital investment or by taking advantage of jobs created by other, more commercially oriented farmers.
 45. The project didn't have a direct approach to targeting women but specified a minimum target of 30 per cent for women in all categories of project investments at appraisal.
 46. **Programme costs and financing.** At design, the expected total cost of ASP was US\$17.2 million. The sources of financing were IFAD, a loan of US\$8.5 million and a grant of US\$0.2 million (51 per cent); OPEC Fund for International Development, US\$5.0 million – to be confirmed (29 per cent); Government, US\$2.1 million (12 per cent); participating financial institutions, US\$0.5 million (3 per cent); and beneficiaries and clients, US\$0.9 million (5 per cent) (President report, para. 25). Given that the co-financing did not materialize by another development organization, IFAD approved an additional amount of US\$5 million as a supplementary loan to fill the financing gap in December 2013. Ultimately, the project disbursed US\$12.8 million (table 2A).

¹⁶ <http://pubdocs.worldbank.org/en/980951472223098077/Georgia-PPA-FY16-presentation-AUG2016-final.pdf>.

¹⁷ FAO, Assessment of the Agriculture and Rural Development Sectors in the Eastern Partnership countries, from <http://www.fao.org/docrep/field/009/aq673e/aq673e.pdf>.

Table 2A

Actual expenditures (disbursements) by component and financier (US\$)

Component	Appraisal budget		Disbursed	
	US\$	%	US\$	%
1. Rural leasing	4 916 200	28.5	2 382 310	18.6
2. Small-scale rural infrastructure	11 000 000	63.8	9 730 247	75.9
3. Project management	1 269 600	8.2	704 261	5.5
Total	17 221 000	100	12 816 819	100

Table 2B

Break-up of actual expenditures by source of contribution (US\$)

Component	IFAD loan	IFAD grant	Government	PFI	Beneficiaries*	Total
Rural leasing	1 725 233	83 940	15 088	558 049	-	2 382 310
Small-scale rural infrastructure	7 832 735	40 269	1 398 401	-	458 841	9 730 247
Project management	601 530	58 683	44 048	-	-	704 261
Total	10 159 499	182 892	1 457 537	558 049	458 841	12 816 819

* The evaluation found that the beneficiaries referred to here are actually the government bodies and semi-bodies such as the Amelioration Company and the municipality.

Source of data: Government PCR, verified by retrieving the data at the date of 23/04/2017 in the Government accounting system.

B. Programme design and implementation arrangements

47. **Timeframe.** The project was designed to cover four years, to be implemented between 2010 and 2014. The initial IFAD loan (802-GE) and initial IFAD grant (1160-GE) were approved in December 2009. Project was declared effective on July 2010 but its activities only started in July 2011 due to changes in the administrative arrangements regarding project management within the Ministry of Agriculture, which then became the executing agency. The project was expected to be completed on 30 September 2014 but was extended by one year to ensure completion of vital works and was formally closed on 31 December 2015.
48. **Changes during project life.** The overall performance of the project was impacted by the political changes in the country over the implementation period. These changes included shifting priorities related to the agriculture sector as well as specific implementation arrangements of the project which went through many changes causing uncertainty and delays in the implementation of project activities and amendments to financing agreement, as elucidated in the following paragraphs. These changes also impacted the original design in terms of the participation of MFIs, the types of infrastructure schemes which were finally selected and the institutional changes in the management of the irrigation sector in the country. The changes in the institutional landscape impacted the overall efficiency and effectiveness of the Project in several significant ways, particularly in terms of disbursements and targets achieved.
49. **Implementation arrangements.** Under the initial financing agreement, the Agricultural Development Projects Coordination Centre (ADPCC) of the Ministry of Agriculture was expected to assume overall responsibility for day-to-day management of the ASP. The ADPCC was established and financed by the World Bank and had previously been responsible for implementing IFAD's projects in the country. A fully staffed team with 13 staff positions was budgeted to support the

implementation of the programme. Additionally, a major part of project implementation was designed to be undertaken through contracted partners. However, in February 2011 the ADPCC was liquidated and the responsibility for the implementation of project activities was passed to the Donor Projects Implementation and Monitoring Division within the External Relations Department of the Ministry of Agriculture. In order to ensure continuity, some staff of the ADPCC were contracted by the Ministry of Agriculture as consultants.

50. **Amendments to the financing agreement.** The IFAD loan (together with the grant) had been amended three times during the course of the project implementation. These amendments were the result of: (i) liquidation of ADPCC and assigning the International Organisation Projects Implementation Department¹⁸ of the Ministry of Agriculture as executive responsibility (12 July 2011); (ii) approval of a supplementary loan on hardened terms in an amount of SDR 3.25 million to provide additional financing to the project (25 February 2013); and (iii) extension of project completion date to be 30 June 2015 and reallocation of a total of SDR 310,000 (Loan 802) and SDR 325,000 (Loan I-802A-GE) from Unallocated to Civil Works category (10 July 2014).
51. **Programme implementation progress.** The rural leasing operations started in February 2012, almost two years late, after the approval of the operations manual. Regarding the participation of PFIs, three Georgian leasing companies had indicated their interest in participating in the project during design. One (Alliance Leasing) was not considered because it was unlikely to pass the due diligence test due to losses in two of the last three financial years. The other (Georgia Leasing) was not interested in participating in the project due to its assessment of the risk in the rural leasing operations in the agriculture sector. TBC Leasing was the only one that participated and 15 enterprises were financed by them.
52. The original project design had foreseen the participation of MFIs. However, IFAD and the Government agreed in January 2012 to initially limit the programme to leasing companies, and reconsider the position of MFIs at a later stage due to the investigation launched by the Chamber of Control. When the MFIs' participation was finally solicited, they were unwilling to participate due a number of reasons. Consequently, no funding was disbursed for this aspect of the project.
53. The scope of the infrastructure component was reduced following the March 2012 supervision mission, during which the Government expressed its priority for the rehabilitation of existing small irrigation schemes. Then, following the Supplementary Financing Design Mission (June 2012), it was agreed to focus on irrigation schemes only in four targeted regions: Mtsheta-Mtianeti, Shida Kartli, Samtskhe-Javakheti and Kakheti.
54. By completion, the project had accomplished works on three types of rural infrastructure: rehabilitation of two deteriorated bridges designed to facilitate transport and communication of agricultural products and the movement of livestock to the summer pastures, building of one drinking water supply system to make better use of available water resources from four springs, and rehabilitation of six irrigation schemes (canals) aimed at covering a potential area of 11,042 hectares.
55. **Project monitoring and evaluation.** During the first years of the programme there did not seem to have been any systematic approach to M&E due to the absence of a M&E specialist. Thus, Progress and Impact reports were not prepared adequately. During IFAD's Supervision Mission in November 2012, the ASP M&E system was established, in line with IFAD guidelines and policies. A staff member from the Ministry of Agriculture took responsibility for managing the M&E system and was oriented in the use of the RIMS system. The M&E specialist regularly

¹⁸ This was further named as Donor Projects Implementation and Monitoring Division.

collected the necessary data related to the outputs/outcomes for both Small Scale Rural Infrastructure and Rural Leasing Components, as well as conducted field trips to project target areas.

56. Key informant interviews by this evaluation revealed that the outreach numbers reported in the PCR were not accurate in some respects. For instance, irrigation beneficiary households mentioned in the PCR (14,453) were potential number, based on potential command area, whilst the impact evaluation notes the actual number as far lower (3,390). Similarly, the numbers for indirect beneficiaries provided in the PCR include those who were already employees and suppliers (farmers) before the project (1,152 and 2,645 respectively). The evaluation reports the *incremental* numbers i.e. those benefitting from project intervention only (612 employees, mostly seasonal, and 993 farmers). The project's outreach is detailed in table 3 below.

Table 3

Data on number of beneficiaries by component type as stated in the PCR and as assessed by this evaluation

	<i>PCR data</i>	<i>Impact evaluation</i>
Rural infrastructure		
Irrigation	14 453	*3 390
Drinking water	500	500
Bridges	540	540
Labour employed during construction	300	300
<i>Total of rural infrastructure</i>	<i>15 793</i>	<i>4 730</i>
Rural leasing		
Enterprise owners	41	41
Employment generation	1 152	**612
Backward linkages (farmers)	2 645	**993
<i>Total of rural leasing</i>	<i>3 838</i>	<i>1 646</i>

Note: * denotes actual numbers; ** denotes incremental numbers.

III. Main evaluation findings

A. Project performance and rural poverty impact

Relevance

57. IOE defines relevance as the extent to which the objectives of a development intervention are consistent with beneficiaries' requirements, country needs, institutional priorities and partner and donor policies. It also entails an assessment of programme design and coherence in achieving its objectives. Based on the above definition, this section of the report assesses relevance from several dimensions.
58. **Relevance of objectives.** The project aimed to: (i) remove infrastructural bottlenecks that inhibit increasing participation of economically active rural poor in enhanced commercialization of the rural economy as well as (ii) increase the assets and incomes among the actually and potentially economically active poor rural women and men willing to move towards commercially viable agriculture and other rural enterprises. Ostensibly, the first objective was to be achieved through the small scale rural infrastructure component and the second through the leasing component. These objectives were consistent with national policies, IFAD's strategies and the needs of the rural poor. However, whilst the underlying aim in both objectives seems to be a move towards commercialization, there are questions regarding the level of the two objectives. For instance, whilst the first objective seems like an immediate outcome i.e. removing bottlenecks, the second is more of a longer term objective i.e. involving increase in incomes and assets.
59. **Alignment with national policies.** ASP objectives were fully relevant and responsive to national policy priorities. At project outset, the 2003-2015 Economic Development and Poverty Reduction Programme of Georgia (EDPRP) specifically mentioned support for the establishment of leasing companies, which the leasing component of the project responded to and prioritized the development of infrastructure in rural areas, including irrigation rehabilitation, road and bridge improvements. Similarly, ASP objectives were fully consistent with The Ministry of Agriculture Strategy of Agricultural Development in Georgia (2012-2022) and The Revised Strategy of 2015-2020 under which the over-arching vision was to create an environment that will increase competitiveness in the agro-food sector, promote stable growth of high quality agricultural production, ensure food security and eliminate rural poverty through sustainable development of agriculture and rural areas.
60. **Coherence with other donor projects.** ASP rural poverty reduction objectives were also coherent with those of other projects in the country including an earlier World Bank Irrigation and Drainage Community Development Project that closed in June 2005 as well as to the current World Bank rural development priorities under the Georgia Irrigation and Land Market Development Project (GILMDP). Similarly ASP related well with current USAID interventions through the Restoring Efficiency to Agricultural Production Project that shares a relevant focus on the promotion of commercially viable agricultural and rural enterprises targeted at small-holder households.
61. **Relevance to the COSOP and IFAD strategies.** ASP was also fully compliant with IFAD's corporate Strategic Framework and with the relevant 2004 country strategic opportunities paper (COSOP), which was in place at the time of project design. The COSOP aimed at improving the productive capacity of the rural poor, enhancing their access to product market, and increasing their share of market value of produce, empowering rural women, and conservation of natural resources. Small scale infrastructure projects were highly relevant to the productive capacity of the rural poor, enhancement of access to the product market, and conservation of natural resources, particularly through the irrigation sub-component of the

project. The intentions of the rural leasing component's design were also geared towards achieving these goals.

62. **Relevance of approach.** The small-scale infrastructure component was relevant to the needs of the poor, with access to infrastructure considered a key issue faced for the overall development of the rural economy. At the time of project design, it was assessed that the country's irrigation system was in a state of disrepair and virtually no investments were made and no maintenance operations conducted since 1991. Most of the main canal performance was far below the initial design capacity (30 to 40 per cent) and the low efficiency of the system meant that farmers even close to the main canals barely received 50 per cent of the water requested whilst those at the tail end of the system suffered even more.
63. Similarly, at the time of design, rural financial operations in the country were failing to reach poor rural people. The need for fresh rural finance incentives, innovation and greater outreach was to be best met through financial leasing which offered simpler security arrangements, financing of a higher percentage of the capital cost of equipment than bank borrowing and faster processing (PCR, page 10).
64. **Relevance of design.** The project was a two component intervention composed of five sub-components viz., irrigation schemes, drinking water pipe, bridges, leasing to farmer groups and leasing to agro-processor companies. Project design drew from past project experiences of over-complex design and infrastructure sustainability issues by assuring that responsibilities for infrastructural maintenance were established from the outset, namely municipalities (for the bridges) and the Georgian Amelioration Company for irrigation canals).¹⁹
65. The provision of reliable and timely irrigation water was of relevance, being a main pre-cursor to improved crop productivity, diversification and thus farm incomes. However, little emphasis seemed to have been placed on assessing the existence and capacity of water users' associations.²⁰ The rehabilitation of two bridges was aimed at increasing access of livestock to summer pastures, constrained, at the time of project design, by their unpassable condition that potentially caused risk of livestock deaths from falling over from the bridge. Similarly, the proposed design to promote private enterprise in the agricultural sector through lease financing, thereby increasing the number and volume of backward linkages to ASP target groups in terms of employment generation and in increased raw material demand and enhanced domestic and export market penetration appeared sound.
66. The relevance of these components notwithstanding, they were a discrete set of activities with little synergy amongst them. Further, the geographic areas of interventions of these sub-components were also different. The drinking water component that aimed at bringing potable water to beneficiary houses was clearly not related to either of the two project objectives. Finally, design of the proposed group leasing scenario did not adequately take into account the local context and the legal framework for leasing operation with MFIs. Notably, the IFAD Quality Enhancement (QE) and Quality Assurance (QA) Panel Review had suggested that the group leasing model was unlikely to be feasible and its targeting strategy was at the risk of serving medium and large scale agro-processing companies.²¹ Similarly, the basis of estimating demand for rural leasing was not very clear - the project estimated demand based on some studies done several years ago and it is

¹⁹ Rural Development Programme for Mountainous and Highland Areas Project Performance Assessment recommendations.

²⁰ The project management's point of view was that in Georgia fostering collective action requires basing interventions on the free choice of individuals and enabling them to directly discover the need and benefit for collective action.

²¹ There are also major concerns about the absence of a coherent targeting strategy and the likelihood that the project will end up supporting primarily investments in medium and large scale agro-processing companies and large farmers while providing only indirect benefits to the target group (QA minutes, 2009) .

unclear how extrapolation to the current scenario was done and how sound this was (more discussion in the "effectiveness" section).

67. The **logframe** developed by the project unit lacked the necessary structure and content. No outcomes are listed; the section on outputs is blank save for only indicators. No targets were provided against which to monitor outputs and final outcomes.
68. **Relevance of targeting.** The project in general targeted those with the capacity to move towards commercialized agriculture. At design the targeting strategy of the project with respect to small-scale rural infrastructure (SSRI) was that it would cover all of rural Georgia but with special emphasis on regions with high incidences of poor rural people combined with areas with a high productive potential in agriculture resulting in a focus on eight disadvantaged regions. However, in 2012, the Government asked IFAD to consider infrastructure proposals in only four targeted regions only.²² Thus the geographic spread of targeting was reduced but the overall number of beneficiaries (15,790) was retained.
69. Infrastructure rehabilitation intervention targeted smallholders with less than one hectare of land and also called for targeting of Internally Displaced Persons and female-headed households (30 per cent of beneficiaries to be women). However, it is unclear how the 30 per cent target was set and further, how this was to be achieved since no strategy was developed to mainstream gender in the project's targeting approach population.
70. In the case of rural leasing component the design set out guidelines for beneficiary targeting and analysis including measures limiting farm and loan sizes for leasing companies and MFI's.²³ Given previous positive experiences whereby MFIs had effectively established a large smallholder client base and a significant lending programme,²⁴ project design targeted existing MFI channels as an approach to reach large numbers of small holders.
71. To conclude, the design addressed the needs of the rural poor in Georgia, was relevant to national policy priorities and, and took into account the local context. It aimed at expanding the range of rural financial products through an innovative form of rural financing i.e. leasing. However, there were also some shortcomings. The design appeared as a collection of discrete interventions rather than one integrated set, there were some unrealistic and unsound assumptions in the design and no basis was found for the 30 per cent target set for women beneficiaries. *The overall relevance is therefore assessed as only moderately satisfactory (4).*

Effectiveness

72. In assessing effectiveness, this evaluation aims to determine the extent to which project objectives were achieved. This is in line with the definition of effectiveness as provided by the IOE Evaluation Manual which states that it is "the extent to which the development intervention's objectives were achieved or are likely to be achieved taking into account their relative importance". Before doing this though, the evaluation provides an assessment of the effectiveness in the outreach and the project's targeted approach.
73. The findings in this section were determined based on the triangulation of several data and information sources that go beyond the careful review of project documents, data collected using the indicators in the RIMS and M&E data. These include quantitative and qualitative primary data collected by IOE during this impact evaluation, site visits and inspection of various project activities, and

²² These were Mtskheta-Mtianeti, Shida Kartli, Samtskhe-Javakheti and Kakheti.

²³ The smaller scale beneficiary farmers and enterprises would be targeted through imposition of lease ceilings of US\$300,000 for leasing companies and of US\$30,000 in the case of MFI's.

²⁴ Rural Development Programme Rural Credit Component PCR.

interviews with key informants including Government officials, project beneficiaries, institutions and IFAD's operational staff and others.

74. **Outreach.** The SSRI component comprised the rehabilitation of two bridges to facilitate safe livestock movement to summer pastures, one domestic water supply scheme and the rehabilitation of six irrigation schemes. As per the PCR, this component is reported as having reached a total of 15,790 rural households exceeding the appraisal estimate of 12,180. Irrigation rehabilitation provided by far the greatest contribution with a potential to reach 14,450 households and a potential command area of 11,000 ha. However, it should be noted that these are potentials not actuals. Delayed constructions, four schemes were not fully completed until 2015, and partial system rehabilitation at most sites resulted in late water delivery. In the 2015 season just 1,420 ha or 13 per cent of the potential command area had been registered for water supply by Amelioration Company and bought under irrigated cultivation by approximately 3,390 households or 24 per cent of expected beneficiaries (refer to table 3 earlier).
75. Outreach of the rural leasing component was disappointing. At appraisal it was expected that approximately 470 direct and 14,200 indirect beneficiaries would be reached, a gross over-estimation since at completion just 15 enterprises had directly participated, employing 1,152 persons of which only 612 represented an increase over baseline. Of the estimated 2,645 backward linkage beneficiaries, only 993 corresponded to an increase. In summary, overall outreach effectiveness was partial in the case of SSRI and fell short for rural leasing.
76. **Targeting.** Although at design, regions and municipalities chosen for irrigation rehabilitation were targeted to be amongst the poorer, choice was somewhat restricted when project coverage was limited to just four regions. Scheme selection criteria established in the component operational manual were not rigorously adhered to. Irrigation rehabilitation was supposed to benefit all landowners in command areas. However, project documentation, key informant interviews with project staff and focus group discussions with beneficiaries reveal no efforts made by the project to consciously prioritize women household heads. Only in the case of employment generation under lessee enterprises, mainly seasonal work in agro-processing, did women comprise over 50 per cent of the incremental workforce, according to project M&E data.
77. Effectiveness was adversely affected because design of the proposed group leasing scenario did not adequately take into account the local context and the legal framework for leasing operation with MFIs. Notably, the IFAD QE and QA Panel Review had suggested that the group leasing model was unlikely to be feasible and its targeting strategy was at the risk of serving medium and large scale agro-processing companies.²⁵ Unfortunately, this advice does not appear to have been heeded and ultimately all leases were to medium and large agro processing companies, including some of the biggest wine companies of Georgia, and none to farmer groups through MFIs (although, some employment generation in these companies appears to have occurred). This issue also stems from the lack of adequate design phase consultations with key stakeholders. During design, MFIs and three leasing companies expressed interest in the programme. However, ultimately the project could not find suitable MFIs to implement the project and only one leasing company participated. This stemmed from the financial institutions being unable to meet the minimum requirements for project participation as well as lack of interest.
78. In order to quantitatively evaluate the project's targeting approach, a probit model was used which derives from the analysis of primary data in the impact survey.

²⁵ There are also major concerns about the absence of a coherent targeting strategy and the likelihood that the project will end up supporting primarily investments in medium and large scale agro-processing companies and large farmers while providing only indirect benefits to the target group (Quality Assurance minutes, 2009).

The analysis offers an indication of the effectiveness of targeting approach by matching the treatment and comparison groups on a set of salient characteristics that influence the participation of households in the programme.

79. As shown in table 4, irrigation users in 2012 (baseline year) and high value crop growers were significantly and positively associated with participation in the project, whilst participation of staple food growers, female-headed households and certain ethnicity and religion were negatively correlated at a significant level. Results of other variables were not significant. It can be surmised that the programme's targeting strategy cast in its ambit more of existing irrigation users and farmers growing high value crops whilst it spared staple food growers, who are mostly smallholders, and female-headed households, who are more disadvantaged sections of rural society.

Table 4
Probit estimates for participation in the programme

	<i>Estimate</i>	<i>Std. error</i>
(Intercept)	0.022	1.018
Household size	-0.030	0.017
Average age of household members	0.003	0.005
Average age of adults in household	-0.004	0.005
Age of household head	-0.003	0.002
Female headed household	*-0.116	0.047
Ethnic Armenian	-0.333	1.010
Ethnic Azerbaijani	0.543	1.076
Ethnic Georgian	-1.277	1.020
Russian ethnicity	-2.600*	1.152
Muslim	** -1.287	0.473
Primary education only	0.639	0.844
No formal education	1.487	0.893
Graduate degree	1.371	1.119
Land owned in 2012	0.000	0.000
Irrigation user as of 2012	***0.531	0.049
High value crop grower	***0.233	0.055
Staple food crop grower	-0.099*	0.050
Amount of land used for agricultural purposes in 2012	0.000	0.000

***p<0.001; **p<0.01; *p<0.05

80. **Effectiveness in meeting objectives. Objective1.** *To increase assets and incomes among actually and potentially economically active rural men and women to move towards commercial agriculture and associated rural enterprises.* It was expected that this objective would be largely achieved through the recapitalization and consequent modernization of Georgian agriculture, specifically among poor smallholders and small and medium agro-related enterprises as a result of the introduction and expansion of rural leasing as a flexible and affordable financial instrument. A working paper²⁶ prepared by the project provided an estimate for the effective, bankable demand for agriculture-related leasing services in Georgia to be around US\$20 million to US\$30 million.

²⁶ *Support for Rural Leasing, Working Paper 1, Project Design Report, Georgia Agricultural Support Project (ASP).*

This is based on extrapolation of results obtained from surveys by USAID and IFC in 2004 which attempted to calculate the bankable demand for leasing in Georgia. It is not clear to this evaluation how the results were obtained in 2004 and how sound was the extrapolation on which the above figures were based.²⁷ Also, it is unclear what scales of agro-leasing these survey results are applied to; how relevant these findings are to small-holder farmers' needs; and whether the demand is from medium-large scale agro-processing companies or SMEs.

81. The most important focus of the capitalization goal was on smallholder farmers who would now be able to afford access to agricultural equipment through a group-based approach to leasing, thanks to the local MFIs who would receive financial support from IFAD. The rigid collateral requirements of commercial banks leave many farmers and other small rural entrepreneurs outside the ambit of banking and MFI financing. Although these are not outlined as risk and assumptions in the project log frame, it was expected that the success of this hinged on the crucial assumptions that: a) the farmers would organize themselves into groups and become group lessees²⁸ and, b) the MFIs would be attracted to this concept given the relatively less risk to be assumed for this type of rural financial product i.e. the leased product could be resituated in case of default in payment by the lessees. In reality, both these expectations were belied, adversely affecting the effectiveness of the project objective.
82. The project was unable to attract MFIs for several reasons, not least because financial leasing as a financial sector instrument is relatively unknown in Georgia and the legislation governing MFIs with respect to this instrument lacks clarity in terms of their remit.²⁹ In addition, MFIs were expected to pay Value Added Tax (18 per cent) upfront when purchasing equipment for onward leasing (to be later refunded by the Government), thus locking-in their funds. Also, the MFIs interviewed by the mission expressed issues that in case of default by lessees there were practical issues of where to keep the equipment that was recovered and their lack of knowledge of markets to sell the recovered (now second-hand) equipment. Finally, there were other competing interventions such as subsidies rental of farm equipment through government centres and through programmes of donor agencies such as USAID that also provided subsidies for the purchase or lease of machinery and which was a formidable source of competition with programmes that tried to work on term credit or leasing. As a result, the technical assistance activity for MFIs was not undertaken by the project.³⁰
83. According to key informants interviewed by the evaluation, farmer groups have not been successful in Georgia after the fall of Soviet Union (although, producer associations for individual agricultural products exist). In addition, majority of the farmers are smallholders, holding on average 0.5 hectares of land. Interviews with farmers pointed to the fact that they were content doing subsistence farming on their small plots (partly because they have other sources of income viz., state pension and remittances and partly because of sub-efficient functioning markets). And those who used agricultural equipment preferred to hire the equipment from their neighbours as opposed to leasing; the latter as a concept

²⁷ The IOE mission had attempted to obtain documents related to the two surveys both from World Bank and IFC, however, the staff interviewed were not able to locate them.

²⁸ Three to four farmers from the same location, who share a mutual trust with each other, would jointly procure farm machinery, such as a tractor. One of them would act as the lessee in the leasing contract, the others would guarantee the payments. The tractor would be jointly used and managed on their farms. In this way, the size of the capital investment would be cut to a third or a quarter of the whole price for an individual farmer.

²⁹ Of the seven licensed institutions operating standard microfinance in Georgia, three had expressed their interest to start agricultural micro-leasing with ASP support.

³⁰ An internationally recruited consultant provided training on the technologies of conducting leasing operations with small-scale rural producers and agro-processing companies. The project-anticipated (two) exposure visits for the key staff of the PFIs, one in the region and one in Western Europe, to learn directly of experiences of rural leasing, including the small-scale group-based rural leasing currently practiced in Armenia, did not materialise. The design also envisaged a co-operation with USAID in leasing-related training, but it failed to be materialized.

was still new to them and one that they feared would end-up locking their funds.

84. The other aspect to achieve the objective (apart from on-farm leasing) was based on the project using registered leasing companies of Georgia to finance rural enterprises' investment in sorting, grading and packaging; marketing of agricultural commodities and/or farm inputs; storage and cold storage; and agro processing. The objective would be achieved through employment opportunities and demand for services and inputs with both backward and forward linkages in the rural economy. The outreach of this was limited to only 15 enterprises that were existing clients of TBC Leasing, the only registered leasing company that participated in this activity. A majority of lessees were wine companies, and most were large companies, some of the biggest in their field, certainly not small or medium enterprises by a mile. Further, interviews with companies revealed that whilst the ASP financing was certainly helpful to them, some of them had planned to take the loan at standard rates anyway, even if the IFAD support had not materialized.
85. The PCR reports that enterprises have created more than 1,152 jobs and established linkages with some 2,700 farmers and enterprises. However, results of focus group interviews with indirect beneficiaries suggested that whilst some lessees increased production, the backward linkages for others were not new but were established with already existing farmer suppliers. In addition, some of the lessees had their own farms where they undertook production (for instance, AMD Agro), implying that they did not create any backward linkages (in addition, no new employees were hired by this company after receipt of IFAD-funded leasing). One reason for companies preferring their own production was to assure themselves of predictable supplies (of primary products).
86. On the other hand, there was potential for further demand which many of the lessees, including the wine companies, hoped to tap into. For instance, leasing beneficiary wine maker KTW's projected demand is at least five times its current production. Those households growing grapes in Racha and other regions which specialize in this variety are expected to receive a much higher price which can significantly enhance their income from the crop. But this cannot be ascertained at the stage of this evaluation. The project has also provided funding for a few start-ups like the Imereti Greenery in Samtredia which set up a high-tech greenhouse project to meet the growing local consumer demand for fresh greens year round. The enterprise has employed 25 people currently and plans on hiring an additional 45 or more staff to its growing enterprise.
87. The effectiveness of the rural leasing component can be adjudged to be effective in attracting new investments in rural enterprises, although, the scale was much lower than envisaged and did not seem to have created new linkages but rather strengthened existing ones. On the other hand, the project's aspiration to introduce rural leasing (on-farm) through MFIs as an appropriate and effective financing mechanism to stimulate investment activity by smallholders was not based on adequate business case analysis.
88. **Objective 2.** *To remove infrastructural bottlenecks which inhibit participation of economically active rural poor in the rural economy.* This objective was to be met through the small scale infrastructure component that initially focused on road, bridge and irrigation rehabilitation but which was eventually restricted to the rehabilitation of irrigation schemes and bridges, and a change to drinking water supply. The two restored bridges, mainly for improved animal access to summer pastures, and one new domestic water supply scheme improved villages access to productive and social services, although the overall effect was modest with just 1,040 households having benefited.

89. The two rehabilitated bridges aimed to facilitate access to summer pastures for livestock and make it safer and convenient for livestock movement. The bridges are generally of good quality and were in good condition, and found to be used by communities for their livestock.³¹ The rehabilitation of drinking water point attained its objective of bringing piped water to the doorstep of beneficiaries who earlier had to rely either on surface water or transport it in their vehicles from the nearest water point.
90. Assured availability of water for irrigation has been a large impediment for Georgian farmers, who depend on a large part on rainfall which can be erratic.³² The fall of the Soviet Union, civil strife and corruption, had all led to a neglect of agriculture resulting in the derelict state of irrigation canals and consequently the fall in area irrigated from 386,000 ha. in 1988 to some 100,000 ha. in 2008. The project offers prospects for improving incomes and greater participation in the rural economy for a potential 14,500 ASP beneficiaries.
91. However, less than 15 per cent of the total command area set as a target by the project was being cultivated at project completion. This is because this was *potential* area to be cultivated after all on-farm irrigation facilities would be undertaken. Even for farmland which is actually receiving water due to the project's intervention, some are owned by families who have long migrated. Where farmers are present and are cultivating, most are subsistence and prefer to stay this way partly due to lack of markets after the fall of the Soviet Union. Field investigations also indicated that reasons for the slow smallholder uptake of newly available irrigation included: lack of access to financial services to fund cultivation and input costs for irrigated planting; an aging rural population with lack of incentives for youth to return to sub-economic farm units and in-complete land registration constraining land consolidation.³³
92. Because rehabilitation works were mainly restricted to headworks, main and partial primary canal rehabilitations, with secondary and tertiary systems remaining un-lined and with little attention given to improve on-farm water management practices, water leakage and poor water use efficiency remains an issue. Some of the farmers interviewed informed that in July-August, when the crop water requirements are at their peak, and precipitation is at its lowest monthly level, there is either no water or a very low level runs in the rehabilitated canals. Although improvements have been made to improve water delivery the full benefit of incremental water supply has still to be realized. Furthermore, despite midterm review and supervision recommendations to improve water regulation and volumetric delivery, little control on individual water extraction is currently exercised.
93. On the positive side, the project brought convenience and an element of predictability to the doorsteps of beneficiaries. Field visits did confirm the improvement in production for some medium to large farms and there are some farmers who switched to high value added crops once the irrigation work was completed. However, the mission notes that since the schemes were mainly rehabilitated as late as in 2015, the extent and pace of the intervention is not measurable in its entirety at this stage.

³¹ This information was received from the survey company selected by IOE (Caucasus Research Resource Center) and who conducted interviews of bridge beneficiaries.

³² For instance, the average amount of rainfall that occurs during the growing season in eastern and southern parts is significantly less than the amount of water required for good crop production. In addition, the effective rainfall is considered to be not more than 50 per cent of the total rainfall that occurs during the irrigation season (especially in the foothills and mountain regions), because the topography is rolling, and the rainfall does not come at regular and optimum intervals.

³³ According to project authorities, some of the farmlands in the project command areas are being used to set up factories and private enterprises which will also affect the amount of land available for cultivation. Similarly, the project management believes that some part of the land which is being irrigated does not show in the contractual records of the Amelioration Company.

94. The full effectiveness of rehabilitation can only be realized if beneficiary farmers are in a position to make complete use of incremental water supplies to improve crop and livestock productivities and to diversify into higher value crop or livestock activities. In the Georgian context, this requires appropriate access to finance, improved farm input supply and access to technological support. ASP took a single factor approach i.e. rehabilitation of irrigation canals only without consideration of key follow up crop and livestock production support services. However, it is noteworthy that this is being rectified under the ongoing IFAD supported Agricultural Modernization, Market Access and Resilience Project that includes rehabilitation of secondary and tertiary systems and provision of extension and technology support.
95. Overall assessment. *Given very mixed component performance effectiveness is assessed as moderately unsatisfactory (3)*. Objective 1 was only partially achieved, due to the non-materialization of the leasing sub-component related to MFIs. The low offtake by enterprises (only 15 in number) and the fact that they were mostly big companies, not small or medium, and that these enterprises reinforced some of the existing backward linkages but did not create noteworthy new ones, was also a factor that thwarted the full achievement of the objective. The project, as part of fulfilling objective 2, helped remove some of the impediments to rural growth viz., access to pasture for livestock and water for irrigation. The former was achieved. However clearly, the targets set for irrigation related activity were over-ambitious and were not achieved. Given that irrigation schemes were rehabilitated towards the end of the planned project duration, it is difficult to assess increases in farm productivity at this stage. In addition to this, given various impediments facing smallholders it is not possible to estimate whether and how long it will take to achieve full achievement of this objective, but clearly, it will be a gradual process.

Efficiency

96. The assessment of efficiency attempts to examine how economically resources and inputs are converted into results. Given the lack of reliable data to conduct cost benefit analysis at programme completion, this evaluation used several proxy indicators to make an assessment of programme efficiency.
97. **Economic and financial perspectives.** Incremental benefits were largely expected to be derived through increased crop productivity and diversification to higher value products resulting from improved irrigation of smallholder farms. Benefits were also to accrue through reduced transportation costs and post-harvest losses due to road rehabilitation; and reduction in post-losses due through improved mechanization, however there is no evidence of this having happened. Economic analysis at design was based on three financial models; a farmer group leasing machinery to cultivate 20 ha of their own land and 200 ha through contracting; leasing of tractor and trailer for a 3 ha apple orchard; and expansion of a small scale milk processing plant. None of these models was replicated under the project.
98. The economic analysis in the PCR reported an Economic Internal Rate of Return (EIRR) of 20 per cent with a net present value (NPV) of US\$164 million based on the incremental income flows from increased access to irrigation, bridge, and leasing activities over a 20-year period, not including the project implementation period. However, the calculation isn't reliable due to the absence of quality impact data and ill-founded assumptions. Specifically, the NPV was actually reported as GEL 164 million in the endline survey report, equivalent to US\$67 million based on zero maintenance and operation costs of the infrastructures for 20 years period with full usage of the rehabilitated command area, which are untenable. Additionally, the EIRR was estimated based on a total of 11,040 ha and 15,790 beneficiaries. However, as stated in the Effectiveness in outreach paragraph, given that the full irrigation command potential of 11,040 ha has not yet materialized

with just 3,400 ha of irrigable area actually cultivated at project completion, the anticipated accrual of benefits will be reduced and delayed. Whilst it has not been possible to assess the impact this will have on the EIRR it will clearly be less than expected.

99. At project completion limited incremental benefits had accrued due to the delayed completion of irrigation schemes, slow take up of newly available irrigable lands by landowners, and inability of many small farmers to afford critical factors of production to take advantage of new irrigation potentials, thus only limited increase in productivity and diversification has accrued to date. In the case of the leasing component which largely failed to reach target beneficiaries anticipated benefits have not materialized.
100. **Effectiveness gap.** With only one year between loan signing and effectiveness this process was managed efficiently. Implementation was subsequently delayed by at least one year due to changes in project management within the Ministry of Agriculture leading to staff re-assignments and recruitment of new staff. Delays in the preparation and approval of the component operational manuals, protracted negotiations with potential partner MFIs and delays due to the dearth of competent irrigation design, construction and tender management engineers, delayed the irrigation scheme tendering and approval by up to two years.
101. The above led to delay in completion of some irrigation schemes and a need to extend the loan closing date by one year. Despite the extension, project funds were not fully disbursed, with the overall **disbursement rate** reaching 76 per cent of funds committed at project appraisal. The infrastructure component disbursed 92 per cent of the originally planned funds. The exclusive focus of the project on the rehabilitation of irrigation schemes late into the project cycle propelled the overall disbursement rate.
102. The actual cost ratio of project management was just 6 per cent of total disbursements, lower than comparable projects, and indicative of commendable efficiency by the PMU. An analysis of irrigation rehabilitation costs indicated that on average the irrigation rehabilitation costs were GEL 1980 per ha under ASP, in the range GEL 1244 to GEL 2713 depending whether headwork construction was involved. This is in line with the World Bank's estimated rehabilitation costs of GEL 2150 per hectare.
103. The project initially covered all poor regions of rural Georgia but such a dispersed geographic coverage stretched management capacities and efficiency. However this was addressed to some extent in June 2012 when it was agreed to limit ASP future works to irrigation rehabilitation in four targeted regions.
104. The PCR does not state the cost per beneficiary. This evaluation has therefore calculated it here, using the revised beneficiary numbers (as depicted in table 3 earlier). Taking the actual project costs (amount disbursed), the cost per beneficiary for the *leasing* component works out to US\$362 (cost as per PCR beneficiary numbers is US\$155). For the *small scale infrastructure* component (irrigation schemes, bridges and drinking water), this cost is US\$514 (as opposed to US\$154 obtained using PCR beneficiary number). Although similar IFAD-supported projects for leasing could not be found, costs per beneficiary for an IFAD-supported project, the Rural Development Project for the North-West in Azerbaijan, that was implemented in the same Division (NEN) and with productive infrastructure rehabilitation also being one of the components, was US\$301.
105. Whilst project management cost ratio is relatively low compared with other comparable projects, the economic and financial return of the project was significantly over-estimated in the PCR given the more realistic lower outreach number and the delayed materialization of the expected benefits in the infrastructure component. These were also reflected in the higher than anticipated

cost per beneficiary. The lower disbursements, two-thirds of the original funds earmarked, even with one year extension indicated an inferior efficiency level. *Overall efficiency is therefore assessed as moderately unsatisfactory (3).*

Rural poverty impact

106. IOE defines impact as the changes that have occurred – as perceived at the time of evaluation – in the lives of rural people (whether positive or negative, direct or indirect, intended or unintended) as a result of IFAD-funded interventions. In order to measure the changes and improvements in the quality of life of the population in the programme areas, the evaluation carried out a quantitative and qualitative assessment focusing on the four impact domains described the IOE evaluation manual, as appropriate to the present project. These include: (i) household income and assets; (ii) food security and agricultural productivity; (iii) human and social capital and empowerment; and (iv) institutions and policies.
107. Before presenting the results, highlighting some key points related to the rural poverty impact are in order. One, the quantitative results presented below are computed mostly using a DID approach where the outcome variable is the reported value of interest for 2016 subtracted from the recalled value for 2012.³⁴ In instances where the difference in difference approach is not possible due to data availability or given the nature of variable, for e.g. dietary diversity and food spending (where the accuracy of recall responses for baseline year is impossible to guarantee), a simple with-without comparison of the endline results between treatment and comparison group is presented. Before-after tests, which test for a change between 2016 and 2012 for individuals only in the treated group, are only used in one case (increase in livestock) in order to better understand results of the difference in difference.
108. Two, given that the four main project intervention types (irrigation rehabilitation, bridge rehabilitation, construction of drinking water system and lease-financing) were disparate - in terms of their nature, type of beneficiaries targeted and location – results are presented for individual intervention type. The evaluation team therefore strongly believes that this decomposition of results as opposed to the overall project results is a more telling representation of the project's effects. There is also the fact that the average overall effects of the project for some of the main outcome variables are mainly influenced by one intervention, viz., leasing, as is evident later in this section. The overall effects are presented in annex X.
109. Three, the project management unit had undertaken an endline impact evaluation survey. The results obtained therefrom are presented and discussed only where key outcome variables measured by the project-commissioned survey and IOE-conducted survey can be compared.
110. Four, whilst interpreting the impact evaluation results, it is key to take cognizance of the context in which the ASP project took place. Following the 2008 August war, development aid flew into most of the country with at least US\$2 billion spent, with more aid in subsequent years. Aid money generally has been concentrated in many of the areas which the ASP project took place, and particularly in the ethnic minority and conflict affected areas where the infrastructure component took place. Since 2013, the current Government has also carried out a significant number of programmes aimed at developing agriculture including a programme that provided free vouchers for purchase of fertilizers and free ploughing service for land using mechanized implements, which coincided with the implementation period of the ASP project. Given that many of the communities in the evaluation's infrastructure

³⁴ Given a two-period setting where $t = 0$ before the program and $t = 1$ after program implementation, letting Y_t^T and Y_t^C be the respective outcomes for a program treated and non-treated units in time t , the DID method will estimate the average program impact as follows:

$$DID = E(Y_1^T - Y_0^T | T=1) - E(Y_1^C - Y_0^C | T=0)$$
where $T_1 = 1$ denotes treatment or the presence of the program and $T_1 = 0$ denotes untreated areas.

component control group also benefited from development programmes, with- without comparisons in regard to the infrastructure component are likely to measure impact *relative to* other development projects which took place in control communities.

Household income and net assets

111. In line with the IFAD Evaluation Manual, the evaluation in this section assessed household income as the flow of economic benefits accruing to a household including increased incomes from agricultural and non-agricultural sources as well as increased assets.
112. *Household income.* The survey measured household income along a number of dimensions, including *agricultural income* for households and *non-agricultural incomes* for individuals within the household from self-employment (including business ownership) and employment. Results for change in household's *physical assets*, as a proxy for income, are also shown. In addition, the data also allow for the testing of whether ASP interventions helped families move from the bottom quartile of the income distribution as defined by 2012 incomes adjusted for inflation. The findings for agricultural and non-agricultural incomes are shown at the outset, in table 5, and the ensuing paragraphs then discuss these results in greater detail, including through the lens of the casual pathway that helps provide perspective to the individual interventions.
113. *Agricultural income.* The DID analysis shows no statistically significant changes in agricultural incomes for irrigation, bridge, and drinking water communities between treated and untreated communities but only for the leasing community (table 5). In other words, there is a high likelihood (based on conventional thresholds) that the average increase or decrease in incomes of treated households as compared to the selected untreated households is attributable to random chance and not to project interventions, except in regards to the leasing component.³⁵

Table 5
Changes in agricultural and non-agricultural incomes: DID effects (in local currency)

<i>Intervention type/variable</i>	<i>Agricultural income</i>	<i>Non-agricultural income</i>
	135.69	81.51
Irrigation community effects	(172.08)	(298.01)
	-547.67	15.675
Bridge community effects	(496.06)	(1 329.203)
	-113.023	-619.89
Drinking water community effects	(109.399)	(1 093.55)
	4173.01	972.54
Leasing community effects	** (1 358.51)	(716.37)

***p<0.001; **p<0.01; *p<0.05 (p value indicates the probability of observing a difference if no difference exists). Estimates are presented with clustered standard errors in parentheses.

114. The *causal pathway* for the irrigation intervention was that availability of regular irrigated water would lead to increased farm productivity through crop yield increases and to diversification of cropping patterns and crop technologies. These in turn would result in higher household income and consumption. There are two possible explanations for the irrigation related results obtained from the impact survey. First, it is likely that the effect of any changes in farm productivity due to the availability of irrigated water, and the ensuing changes if any in income, are

³⁵ On the other hand, the results of the project-conducted impact evaluation study show the growth rate of household income to be two per cent in favor of beneficiaries using the DID approach.

yet to materialize (given that most irrigation works were completed quite recently). This especially applies in cases where farmers have switched from crop to fruit trees, which can take at least five years to bear fruit and generate income. A second factor is the lack of adequate water supply in the main watering season *and* the absence of on-farm irrigation due to the project's focus mainly on primary and secondary canals.

115. The *causal pathway* for bridge community benefits was that through increasing livestock numbers by decreasing losses from animals falling off of dilapidated bridges and easing access to pasture lands, more livestock related output would result. This evaluation though considers the logical benefit from the bridges to be the increase in cows and calf numbers (the latter, as a result of a higher calving percentage due to an increased plane of nutrition resulting from assured access to summer pastures). The DID analysis suggests an increase of 0.07 calves on average ($p < 0.05$) in favour of beneficiaries (table 6) but no significant change in the case of cow numbers.³⁶
116. Whilst it is tempting to conclude that the project intervention led to an *increase* in calf numbers, it is important to combine this result with the before-after results in order to get a better perspective (i.e. number of cattle that the beneficiaries had in 2012 versus the number they had in 2016). The latter shows no statistically significant change i.e. the calf numbers did not change in beneficiary communities after project intervention. Combining the findings from both results shows that either: a) there was no change in the beneficiary group, but in the counterfactual group the number of calves *declined*, or, b) calf numbers declined in both treatment and control villages but more so in the control group.
117. However, given that the increase in livestock (calves) number was very marginal, it is likely that this is also reflected in the no significant increase in agricultural income registered by bridge communities (in table 5 above).

Table 6

Changes in livestock numbers for bridge communities (in units): DID effects

Variable	Cows	Calves
Bridge community effects	-0.34218 (0.38466)	0.071 (0.034)*

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Estimates are presented with clustered standard errors in parentheses.

118. The *causal pathway* for drinking water sub-component of the infrastructure component aimed to increase access to drinking water. Although its explicit aim was not to increase incomes, the evaluation hypothesized that savings in time to fetch water³⁷ would lead to more time freed-up for other possible activities, including, for gainful remuneration. The results in table 5 showed no significant change in incomes. On the other hand, results show a three-minute saving in water fetching for the drinking water communities compared with matched control groups, but it is not statistically significant (table 7). In addition, results show that the drinking water communities were 8.76 times more likely to have a drinking water system go into their household than the control group (table 7). This suggests that the drinking water treatment communities indeed gained access to in-house water systems. Although not stated as an explicit goal of the project, the evaluation also attempted to assess any health related impacts for drinking water community thanks to availability of drinking water (as opposed to using surface water). In-depth interviews did not reveal any particular improvement in health for

³⁶ The results shown by the impact evaluation by the project unit on the other hand show changes in cow numbers to be in favour of the treatment group with the growth rate of the number of cows about five per cent higher than the control group.

³⁷ The participants of focus group discussion revealed that all members of the family, male and female, contributed to collection of water for the household.

beneficiaries in terms of visits paid to health clinics before and after project intervention.

Table 7
Changes in drinking water community (DID effects)

Variable	<i>Drinking water system (exponentiated likelihood ratio)</i>	<i>Time to fetch drinking water (minutes)</i>
Drinking water community effects	8.76 (0.63)***	3.29 (2.41)

***p<0.001; **p<0.01; *p<0.05

Estimates are presented with clustered standard errors in parentheses.

119. Finally, the *causal pathway* for the part of the leasing component related to IFAD-financed loans to rural enterprises (agro-processors) to lease equipment leading to increased capacities that would then create backward linkages for indirect beneficiaries in the form of increased employment (in lessee-run operations) and increased supply of inputs (primary products) from farmers. Results of the household survey presented in table 5 earlier show that the interviewed indirect beneficiaries i.e. grape growers did experience an average increase in incomes, with point estimate (average) of GEL 4,173,³⁸ (p<0.01); the 95 per cent confidence interval of this estimate, though, suggest a large range of GEL 1,510 to GEL 6,835 impact.³⁹ Taking this minimum value of GEL 1,510 suggests a 14 per cent increase in total incomes from baseline. If the effect is converted into constant 2012 local currency terms, the minimum increase in real terms is 10 per cent (point estimate GEL 3,900; interval: GEL 1,172-6,628). However, in the absence of any target set by the project in this regard, it is difficult to comment on this result. This is in line with what this evaluation had considered as the likely effect size of the project.⁴⁰
120. Focus group discussions suggest that grape farmers generally reported increased grape production in recent years. The reasons for increase in grape production *inter alia* include those related to politics and markets. Participants of the focus group discussion mentioned that under the previous Government (prior to 2012), conditions were not very conducive for agriculture and hence farmers were discouraged from selling. The other reason is that the frontiers of markets for Georgian wines have been expanding with the product now having permeated into countries such as China with a huge potential. It also has to be admitted that IFAD's leasing finance was only used for very limited operation for most of the large-scale enterprises.
121. *Non-agricultural incomes.* In order to test for impact on non-agricultural incomes, a variable was created composed of incomes from employment and self-employment outside of working on one's own land, including from working in one's own business and on others' agricultural land. Incomes from rent, remittances, gifts, and government transfers were not included since ASP interventions were not expected to increase these types of non-agricultural income. Statistical analysis presented in table 5 earlier suggests that the project did not have any significant impact on non-agricultural incomes, as envisaged in the project log frame.
122. *Moving out of poverty.* Ultimately, IFAD aims to help the rural poor to move out of poverty. One way of testing whether the project achieved this goal is to test whether households in treated communities were more likely to move out of the lowest quarter of the income distribution in 2012. A logistic regression was used to test whether individuals in treatment communities were more likely to move out of the bottom quartile in 2012 terms than in control communities using total income from both agriculture and non-agriculture, adjusted by inflation rates.

³⁸ If outlier observations are controlled for, the average effect size is 3235 GEL (p<0.001).

³⁹ These are calculated using the clustered standard errors also presented in Table 5 and the commonly used measure of 1.96 standard deviation from the mean.

⁴⁰ No targets had been set by the project in this regard. The 10 per cent effect size was based on other.

123. The results of the DID analysis are presented in table 8 by way of probability statistics (both in likelihood terms and log-likelihood terms). The results from likelihood ratio suggest that indirect beneficiaries of the leasing component were 205 per cent ($p < 0.05$) as likely to move out of the bottom quartile of the 2012 income distribution. No significant effects were found on this indicator from other two project activities. In other words, there is a very high likelihood that the poorest 25 per cent amongst indirect beneficiaries of leasing component in 2012 would have improved their incomes; but not the beneficiaries of other sub-components.

Table 8

DID effects of moving about baseline bottom quartile for different communities

<i>Intervention type/variable</i>	<i>Likelihood ratio</i>	<i>Log-likelihood ratio</i>
Irrigation community effects	0.7408182	-0.300 (0.368)
Bridge community effects	6.746339	1.909 (0.779)
Drinking water community effects	1.683711	0.521 (0.638)
Leasing community effects	2.050328	0.718 (0.363)*

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Estimates are presented with clustered standard errors in parentheses. These apply to both types of ratios presented.

124. *Physical assets.* Another indicator of economic impact is the assets that households own. In order to assess whether the project increased a household's physical assets, principal components analysis⁴¹ was carried out to create an asset index.⁴² The principal component which was most highly correlated with the sum of assets purchased after 2012 was then extracted and regression analysis was used to test whether the project had an impact on household assets.
125. The results suggest that the indirect beneficiaries of the leasing component increased their assets following treatment. The first principal component was strongly negatively correlated with the sum of items a household purchased after 2012 ($r = -0.938$). Hence, a decline on this indicator suggests an increase in assets. Regression suggests that leasing beneficiaries experienced a decline on this indicator of 0.18 ($p < 0.05$). This suggests an increase in assets for indirect beneficiaries of the leasing component. Thus, in the case of indirect beneficiaries of leasing component, both agricultural incomes and assets are likely to have increased. No significant effect was found in irrigation communities or drinking water communities on household assets.

⁴¹ Principal component analysis is a technique to convert a set of correlated variables into a smaller set of non-correlated ones.

⁴² These assets include: Internet; Refrigerator; Washing machine; TV; Personal Computer/Laptop; Motor cycle/Quadrocycle; Vehicle; Micro Bus; Tractor (including moto blocks); Gas/Electric oven; Mobile phone without internet access; Mobile phone with internet access; Air Conditioner; Satellite Dish; Electric/Gas Heater.

Table 9
With-without effects on physical asset wealth

<i>Intervention type/variable</i>	<i>Principal component of physical asset wealth</i>
Irrigation community effects	-0.106 (0.132)
Bridge community effects	-0.249 (0.113)
Drinking water community effects	-0.135 (0.118)
Leasing community effects	-0.180 (0.081)*

Note: This estimate is not based a difference in differences approach, but rather on whether individuals were able to buy assets after 2012.

* $p < 0.05$

Estimates are presented with clustered standard errors in parentheses.

126. In conclusion for the household income and assets section, the DID analysis provides positive results in relation to agricultural incomes only among the leasing component's indirect beneficiaries. The leasing components also had larger chances of moving out of the bottom quartile of the income distribution.

Food security and agricultural productivity

127. The assessment of food security and agricultural productivity entails the assessment of changes in food security related to dietary diversity and spending on food as well as changes in agricultural productivity, which are measured in terms of yields. Yields aside, if individuals cultivate a greater amount of land or are able to increase the amount of land they irrigate, this suggests the potential for increased agricultural production. A move towards high value crops could also suggest increased commercialization and thus increased productivity. These values are also tested within this section.
128. **Food security.** The evaluation used dietary diversity as well as spending on food as indicators of food security. These measures were selected given that traditional survey questions about missed meals and the hungry season in Georgia are less applicable to the Georgian context and subject to relatively large social desirability bias. In contrast, dietary diversity is both a valid measure of food security⁴³ as well as prone to less social desirability bias.
129. *Dietary diversity.* Dietary diversity represents a measure of household access to a variety of foods as well as shows whether the household can achieve sufficient nutritional intake. As noted above, dietary diversity is a strong measure of food security. To measure it, a standardized United Nations Food and Agricultural Organization (FAO) questionnaire was administered to respondents, with 16 categories of food. After data collection, the questions were recoded into a 12 point scale as suggested by FAO. No significant impact was established in any community (table 10). For instance, the results of analysis estimate that the dietary diversity is 0.18083 points higher on a 12 point scale in irrigation communities. However, the effect was *not* significant. Hence, we find no effect on dietary diversity in the irrigation communities.
130. *Spending on food.* Increased spending on food may suggest that beneficiaries have greater food security, as they are able to spend more on food. But no significant effect was found in spending on food items in 2016 between treatment and comparison groups. Thus, for instance, even though results show that treated irrigation communities could have spent 135 per cent more on food than untreated

⁴³ Kennedy, Gina, Terri Ballard, and Marie-Claude Dop. Guidelines for Measuring Household and Individual Dietary Diversity. Technical paper. FAO.

irrigation communities, from a statistical viewpoint, taking the p value into consideration, the result is zero i.e. no change.

Table 10

With-without effects on food security (endline year difference between treatment and comparison groups)

<i>Intervention type/variable</i>	<i>Food spending</i>		
	<i>Dietary diversity</i>	<i>Likelihood ratio</i>	<i>Log-likelihood ratio</i>
Irrigation community effects	0.18083 (0.35659)	1.354998	0.3038 (0.2423)
Bridge community effects	-0.90698 (0.55833)	1.060987	0.0592 (1.5728)
Drinking water community effects	0.33981 (0.18404)	2.235802	0.8046 (0.5989)
Leasing community effects	-0.06400 (0.26545)	1.249946	0.2231 (0.1806)

Note: Neither of these estimates are based on differences in differences approaches. Rather they are based on endline estimates, i.e. difference between treatment and comparison groups, because neither variable could be reliably measured using recall for 2012.

***p<0.001; **p<0.01; *p<0.05; p<0.1

Estimates are presented with clustered standard errors in parentheses.

131. **Agricultural yields.** Within the ASP project, if the irrigation subcomponent was effective, we would expect to see a significant increase in agricultural yields, while in other project components there is no reason to expect an increase in yields stemming from the ASP project intervention. Hence, analysis was carried out on yields (kg/Ha) in irrigation communities for potatoes, corn, onions, beans, apples, grapes, tomatoes and cucumbers, and plums and apricots. These crops were selected given that there was a sufficiently large part of the sample which grew these crops in both 2012 and 2016 for inferential statistics to be carried out. The DID analyses show no significant changes in yields.
132. Although the irrigation component attempted to improve the irrigation system, the changes appear to have not been enough to help the farmers in the communities. Focus group participants frequently complained about the lack of regular water available for irrigation. This is a likely cause of the lack of increase in yields. However, the field observations of the project's agricultural expert suggest that farmers are attempting to make use of the system to increase yields, which may bear fruit in the long term.
133. *Irrigated land and land cultivated.* The results of the DID analysis (table 11) suggest that in irrigation communities no additional land was brought under cultivation by beneficiary households (the increase of 1,253 square meters is not statistically significant). However, average size of irrigated land per household did increase by 1,495 square meters (p<0.05), or approximately 0.15 hectares. The PCR reports the difference between the change rates of areas of land provided with irrigation to be five per cent in favour of the treatment group.
134. *Results obtained from NDVI analysis.* The results obtained from the geospatial analysis show that a statistically significant negative BACI contrast (i.e. improvement in NDVI of treatment areas with respect to control areas after the intervention) was detected in 7 out of 14 samples; however, only four have a significant 0.05 P-value. Focusing on the sites for which a significant BACI effect was detected, the average relative contrast is -1.24 per cent. Considering the NDVI as a rough approximation of the fractional vegetation cover, these numbers translate into an improvement of 1.24 per cent in the vegetation development for

treated areas with respect to the control areas. This result can be linked to the above outcome from the survey that showed some increase in irrigated land.

135. *Crop diversification.* Diversifying from food crops (staples) to high value added crops which would primarily be grown for market would be a sign of marketization among the rural poor. However, since farmers in Georgia regularly try out different crops, a simple indicator of whether a farmer changed crops is not possible. Hence, the amount of land dedicated to food crops and amount of land dedicated to high value added crops was tested. DID analysis in table 11 shows no significant impact from project activities.

Table 11

DID effects on land (change in amount of land in square meters) (for irrigation community only)

<i>Variable</i>	<i>Estimate</i>
	1 494.75
Irrigated land	(606.62)*
	1 253.06
Cultivated land	(827.08)
	883.51
Food crop land	(654.12)
	669.20955
High value added crop land	(757.38493)

***p<0.001; **p<0.01; *p<0.05; p<0.1

Estimates are presented with clustered standard errors in parentheses.

136. In conclusion, the project appears to have had little to no effect on food security. The project does not appear to have had a positive impact on dietary diversity. In irrigation communities yields did not increase, with the likely cause being a lack of sufficient water in the irrigation system. The amount of land irrigated did increase, however.

Human and social capital and empowerment

137. Human and social capital and empowerment entails assessment of the changes that have occurred in the empowerment of individuals, quality of grass-roots organizations and institutions, and the poor's individual and collective capacity. In contrast to many IFAD projects, ASP had limited goals in relation to helping build rural institutions through project activities. This impact evaluation considers the following main domains where human and social capital and empowerment could reasonably be related to the project: an increased say in the development process for the beneficiaries, improvements in intra-community relations and improved health outcomes in drinking water communities.
138. *Participation of the poor in development.* IFAD aims to increase the poor's ability to engage in the development process. In this regard, the project organized meetings in infrastructure communities to consult with and confirm that the proposed project would suit community needs. However, the results of focus groups and in depth interviews often suggest that community members were not adequately consulted at the design phase of the project in the irrigation and drinking water communities. It is unclear whether a selection criteria was used for enlisting beneficiary participation to ensure a truly participatory approach to consultation.
139. In bridge communities, interviewees report that they were consulted and that their recommendations were taken into account. In drinking water communities, focus group participants were aware that some consultations took place, although they were not consulted. In irrigation communities, no focus group participant was aware of anyone being consulted about the design. While interviews with key

informants suggest that community design meetings did take place, it appears that they did not reach an adequate number of community members particularly in irrigation and drinking water communities.⁴⁴

140. While not certain, it is distinctly possible that some issues could have been avoided had a greater deal of outreach to community taken place. Practical issues aside, the lack of a more systematic outreach suggests a missed opportunity for the development of human and social capital as relates to the rural poor's involvement in the development of their communities, one of IFAD's goals.
141. *Water conflicts.* Conflicts over irrigation water are quite common in Georgia. As focus group participants reported, these conflicts are usually due to the small amounts of water available during the peak usage season. While one focus group composed of women suggested that the conflicts have declined since the rehabilitation of the irrigation system, the male focus group participants suggested that conflicts have not gotten better. Water conflicts were also prevalent in the drinking water communities prior to project implementation.
142. *Health outcomes.* Good health being an important component of human capital, the impact evaluation hypothesised that improved water supply and a better source of drinking water brought to beneficiaries' houses through the project's intervention could reasonably be expected to have an impact on their health through a possible decrease in water borne illnesses. As a result, in-depth interviews conducted with beneficiaries tested this hypothesis. In Zhoskha, in depth interviews suggested that community members find the new water to be unclean; hence many do not drink it. In contrast, in the other drinking water community, Chrebalo, an in depth interview suggested they do drink the water. However, water borne illness does not appear to have been a concern.
143. To conclude, the project did consult some community members in the design of the project but not adequately enough; as a result, there was little awareness of community members being consulted at least amongst project beneficiaries that were interviewed. While conflicts over drinking water may have dissipated, views were mixed on whether the project impacted irrigation water related conflicts. Although improved health outcomes might be expected from the drinking water community, these issues do not appear to have been present in the drinking water communities, and the quality of water in at least one of the communities appears insufficient to help with water borne illness.

Institutions and policies

144. This domain assesses the changes in the quality and performance of institutions, policies, and the regulatory framework that influence the lives of the poor. At the project's design phase three primary goals were set out for institutions and policies: (i) consolidation of the ADPCC of the Ministry of Agriculture in its role as the institutional focal point for agricultural development in Georgia; (ii) creation of a leasing sector directed to sustainable rural economic growth and poverty reduction; and (iii) beneficiary groups/organizations (Design Report).
145. At project outset, the ADPCC was responsible for international aid projects related to agriculture in Georgia. However, the Centre was liquidated following project start up. Hence, while the project did not achieve this goal, the reasons for doing so were beyond the control of the project team.
146. The project's impact to be realized through changes in the pro-poor orientation of private sector organizations, mainly through creating a leasing sector directed to

⁴⁴ The lack of outreach is reflected in some of the design of infrastructure issues reported in a number of communities. For instance, in communities which received rehabilitated water systems, an interviewee noted that the location of the pipes was less than ideal and that they are often covered in garbage due to their location, creating maintenance issues. When the pipes need to be cleaned or repaired, water also flowed onto the roads, damaging them according to interviewees.

sustainable rural economic growth and poverty reduction, was not successful. In terms of private sector organizations, although ASP intended on creating a market for leasing products for MFIs, this clearly did not work out. On the other hand, the project's engagement with TBC Leasing, a private sector entity, was a noteworthy feature and has spurred the company's interest in rural sector leasing.

147. The third goal aimed to help beneficiary groups and organizations. From project documentation, no evidence can be extracted. Notably, water users' associations could have been an ideal group to develop for the irrigation component, especially given that water related conflicts are common in Georgia. However, the survey suggests no increase in water users' association memberships, with only 11 respondents reporting membership in 2016. Clearly, the project did not encourage water user association development.
148. A before after test of whether individuals reported paying for irrigation water in 2012 and 2016 suggests a statistically significant increase ($p < 0.001$) in the proportion of individuals paying for irrigation water. This suggests that IFAD may have contributed to the increase in the number of individuals paying for irrigation water, an important outcome towards sustainability of the Amelioration company. However, other factors such as the restructuring of the Amelioration Company also likely contributed to the increase in irrigation water payments.
149. In conclusion, the project did not achieve the institutional and policy related goals it set out to at the design phase of the project, with the potential exception of possibly contributing to the sustainability of the Amelioration Company. The lack of success is clearest when considering the leasing sector, at least insofar as creating a sector that can sustain poverty reduction is concerned.

Overall assessment of impact on rural poverty

150. In a broader and more integrated sense, the impact evaluation concludes that the overall rural poverty impact of ASP is *moderately unsatisfactory* (3). Whilst the project achieved positive outcomes for indirect beneficiaries of the agro-enterprise leasing component, no change was observed for several outcomes of interest for other intervention. The project's QE panel report had observed that the impact of the project on the poorer strata of the rural population either through direct participation in project activities or through the generation of employment opportunities in the agriculture sector may be limited; the results of impact evaluation seem to resonate with this observation. It can be argued that given delays in irrigation scheme rehabilitation and the modest uptake by farm households of irrigation at the time of this impact evaluation, it could be a case of unfinished business and that results should be more visible over the due course of time. However, the reality also is that the project had expected results at the end of its implementation, and that is what this evaluation is assessing.

Key summary points

- Overall, there is a high likelihood (based on conventional thresholds) that the average increase or decrease in incomes of treated households as compared to the selected untreated households is attributable to random chance and not to project interventions, except in regards to the leasing component.
- Improvements to the irrigation system appear to have not been enough to help the farmers in the communities improve agricultural yields.
- The project's main success within the irrigation sub-domain is the increase in some amount of irrigated land. However, compared to the original target, only 13 per cent of the total command area of the rehabilitated irrigation schemes was irrigated.
- Results of the NDVI analysis also point to some increase in irrigated land, albeit on a very small scale.
- Indirect beneficiaries of the leasing component had reasonable increases in agricultural incomes; assets too seem to have increased.
- The bridge component appears to have reduced some cattle loss but it is very minor.
- No changes were observed in the food security status of the beneficiaries.
- In terms of empowerment through beneficiary participation in project, results are mixed, with some communities consulted whilst others not.
- In terms of grass-root institutions, the project did not create or support beneficiary associations.

Sustainability of benefits

151. IOE defines sustainability as "the likely continuation of net benefits from a development intervention beyond the phase of external funding support. It also includes an assessment of the likelihood that actual and anticipated results will be resilient to risks beyond the programmes' life.
152. A cursory inspection of the rehabilitated irrigation schemes during field visits by IOE mission showed them to be of generally good quality. Further, the infrastructural sustainability risks have been mitigated to some degree by responsible departments contributing 5 per cent of total infrastructural costs to a central fund as an indication of their commitment to the works created under ASP. In that regard relevant municipalities have accepted responsibility for care and maintenance of bridges and the water supply scheme and Amelioration Company for rehabilitated irrigation. Furthermore, the Agricultural Modernization, Market Access and Resilience Project will complete and strengthen the ASP, Dzevera scheme facilitating its sustainability.
153. The long term sustainability of infrastructure will however depend to a large degree on a communal sense of ownership which is yet to be engendered. Amelioration Company is responsible for the maintenance of all main, primary and secondary canals without beneficiary involvement and with little evidence of farmer involvement in improving the tertiary on-farm systems themselves. It could be argued that there are similar other cases in Georgia. For instance, the evaluation cites an analogous case of livestock support whereby Government continues to provide resources for animal disease control beyond project closure but lacks political will to ensure that smallholder farmers pay the full cost of ECF vaccinations to ensure sustainable delivery of the service. The sustained maintenance of irrigation schemes will also depend on a fair and well organized distribution of water amongst users and on good water management efficiency on farm. In the absence of effective water user associations this is difficult to achieve.
154. The World Bank's GILMD project will introduce institutional reforms within Amelioration Company to promote water users' participation that should also

improve sustainability of completed ASP schemes. The Amelioration Company also confirmed their intentions to promote water user associations and to review current water tariffs. However, since little progress had been made in the introduction of these institutional reforms at the time of this evaluation there is no evidence yet based on which the evaluation can state whether they will successfully allay all sustainability concerns. This impact evaluation regards the success of these reforms as an important issue impinging on the future sustainability of this major component that accounted for some 75 per cent of total project expenditures. Given the current water charge tariff of 75 GEL per ha, compared to an estimated actual cost of 250 GEL, irrigation operations and maintenance will remain heavily reliant on Government subsidy of the Amelioration Company operations and thus subject to financial risk.

155. Sustainability of the leasing component is in a sense secure as all funds invested were distributed to 15 existing and well-established medium and large-sized private enterprises after thorough vetting and diligence testing by Tbilisi Leasing Company. All appear to be prospering and expanding operations and in this scenario it is reasonable to assume that their demand for additional labor and raw material supplies is also likely to grow sustaining the modest backward linkages developed under ASP.
156. Whilst participatory water management and water users' associations have still to evolve provisions under ongoing projects are in place to address this issue and furthermore the Government and the Amelioration Company have undertaken to foster cooperative and group development and to review current un-sustainable water charges.
157. Because responsible organizations have accepted operations and maintenance responsibility for infrastructure from project outset, *sustainability is assessed as moderately satisfactory (4)*.

B. Other performance criteria

Innovation

158. IOE defines innovation as the extent to which IFAD development interventions have introduced innovative approaches to rural poverty reduction.
159. Innovative aspects proposed at project design included: the development of rural leasing especially through farmer groups; institutional innovations to promote participation of water users in irrigation scheme design and water management and introduction of measures to improve water charge recovery and more water efficient delivery to users.
160. The rural leasing proposal was the most innovative feature of ASP. Although Georgia has had some experience with leasing, and although Government, farmers and agro-processors recognize that there is an urgent need to introduce innovative practices to achieve productivity increases, this financing instrument had hardly been employed in the agricultural sector. Carefully and flexibly managed leasing could have offered an option to foster greater inclusion of poorer clients, not least because it removed the collateral constraints of conventional credit.
161. Similarly, based on the successful experience of IFAD's past operation in rural finance,⁴⁵ the anticipation by the project that leasing operations would be channelled through established leasing companies and especially successful micro-finance institutions that were well established in the sector and with a large client base was an optimistic assumption. Unfortunately, there was a lack of sufficient and robust analysis at the time of the design of the MFI-related leasing product and weak support before implementation which culminated in the failure of its

⁴⁵ Under an earlier IFAD project Rural Development Programme, a rural credit had been significantly strengthened through MFI's whereby 10,000 clients were lent a total US\$10.6 million, with repayments exceeding 90 per cent, though group lending was not attempted.

implementation. Innovations need to be prepared and nurtured carefully. On the other hand, leasing to agro-processors was more successful (although the uptake was not as high as anticipated).

162. Institutional innovations to promote participation of water users in irrigation scheme design and water management and introduction of measures to improve water charge recovery however did not occur. There was virtually no discernible water users' participation in scheme design or management, or of a greater sense of system ownership amongst water users.
163. In conclusion, the project attempted to use innovation as part of its interventions. However, there was lack of sufficient analysis (the likely constraints for MFIs and the competition, especially from the rental market for farm equipment) whilst the concept was novel insofar as expanding the range of choices for financial products available to project beneficiaries was concerned. *This evaluation rates innovation as moderately unsatisfactory (3).*

Scaling up

164. IOE defines this as the extent to which IFAD development interventions are likely to be replicated and scaled up by the Government authorities, donor organizations, the private sector and other agencies.
165. As only one leasing company and no MFIs were involved in ASP leasing activities and as all beneficiary leases were medium to large private enterprises, mainly involved in agro-processing and who could equally well have accessed business finance through the established commercial banking sector, at this stage there are no prospects for significant scaling up of rural agricultural leasing. Furthermore, current legal, regulatory and frameworks and tax implications preclude participation of MFIs; although some are reportedly interested to adopt leasing instruments if they were suitably reformed. As there is no apparent inclination on the part of Government to reform leasing regulations acceptable to MFIs there appears very little potential for scaling up this activity in Georgia.
166. In contrast the experience of ASP with irrigation rehabilitation has benefited the design and the development of the World Bank Georgia Irrigation and Land Management Development Project (GILMD) that was approved in 2015. The institutional and management arrangements tested and implemented for irrigation command area re-construction under ASP, and through the project's small scale infrastructure implementation manual, has helped establish the operational modalities for the design of the GILMD.
167. In summary, ASP's experience with irrigation has already had scaling up impacts in both World Bank and subsequent IFAD project designs, whereas the leasing component has had none, and scaling up is thus assessed as *moderately satisfactory (4).*

Gender equality and women's empowerment

168. IFAD's women's empowerment objectives include: (1) expanding women's access to and control over fundamental assets – capital, land, knowledge and technologies; (2) strengthening women's agencies – their decision-making role in community affairs and representation in local institutions; and (3) improving women's well-being and easing their workloads by facilitating access to basic rural services and infrastructures. In this section, an evaluation of the ASP programme's achievement on gender related objectives is provided.
169. In the Georgian context, gender in agriculture is an important aspect of the rural landscape. In terms of gender equality, the country is ranked 90th out of 144 countries in the Global Gender Gap (GGG) index due to a widening economic participation and economic opportunity gap. Women's economic opportunities outside the agricultural sector are limited, with 56.5 per cent of employed women

working in agriculture, compared to a regional average of 16 per cent in Europe and Central Asia. Poverty appears to have fallen less among people living in woman-headed households than among people living in man-headed households. Thus, there was a potential opportunity for the project to address some of these gender-based imbalances in its intervention areas.

170. *Gender targeting.* At the outset, the project had set a 30 per cent minimum number of beneficiaries to be women. It is unclear though how this would be achieved since there was no explicit gender strategy. For instance, in the infrastructure component, rehabilitation of existing irrigation schemes meant that no explicit effort could be made to ensure that schemes targeted women; farmer households that were in the command area of the schemes would benefit, regardless of whether or not they were women-headed. The leasing component also appeared to be less successful in this regard; no gender targeting was done in terms of setting a minimum target for rural enterprises to be headed by women. In terms of employment, in-depth interviews with companies suggested that some of them did hire women to work.
171. *Women's voices being heard in development.* The focus group discussions carried out with women suggested that none of them nor anyone they knew had been consulted in regards to the project design. While key informant interviews suggest that project outreach events in communities indeed did take place, these efforts appear to have been unsuccessful. Considering that community members in general were not reached out to, it is unlikely that women's voices were adequately heard in the decision making process.
172. *Rural poverty impact on female-headed households.* As far as project impact goes, the DID analysis of female-headed households suggests no significant impact on any of the outcome variables of interest such as income, food security, moving out of poverty and asset index (see annex X). Thus, female-headed households were not better off than the comparison group for these variables.
173. *Gender dynamics: IFAD-supported projects aim to increase women's access to and control over fundamental assets and their role in decision-making.* To measure whether the project had succeeded in achieving this, the survey included questions on whether men, women, or both men and women have a say in:
 - (i) Decisions related to asset purchases;
 - (ii) Decisions related to what agricultural products are produced;
 - (iii) Decisions related to which agricultural products will be sold or given away;
 - (iv) Decisions related to planting and taking care of the land.
174. The evaluation undertook a with-without analysis of all of the above indicators. In addition, since the survey's design also allowed for before-after analysis of gender dynamics, this is presented in relations to planting and taking care of the land. Since ASP did not include any gender specific project components or activities which would plausibly lead to increases on these or other gender-related indicators, the analysis was carried out on the entire sample.
175. The results of with-without analysis suggest no significant changes in women's role in the decisions about buying assets, choosing which agricultural products are grown/harvested/ produced, deciding which agricultural products will be sold or given away, or in how the land will be planted and taken care of. The situation before-after also did not change. Focus group discussions noted that whilst women were sometimes consulted in these matters, decisions were taken by men.
176. *Women's work burden:* One of the fundamental aims of IFAD projects' focus on gender is to ease women's work burden as a means to improve their well-being. Within ASP, the drinking water component led to construction of in-house drinking water pipelines. The with-without analysis suggests no significant change in the share of households reporting that women are primarily responsible for fetching

water for the household. This is likely because households which received water often reported that before project intervention, everyone equally, males and females alike, went to gather water. On the other hand, the interviews noted that many women in the villages use the piped water for running their washing machines and for other cleaning tasks. Hence, this intervention likely had a positive impact.

177. Thus, of the areas that this evaluation considers key to evaluating gender equality and women's empowerment, and which were consequently evaluated through the household survey and focus group discussion, none showed noteworthy outcomes. The results are a reflection of the fact that although the project adopted a target for women beneficiaries, the modalities for ensuring women's participation and representation in local groups and organizations were not outlined. Similarly, there was no gender-related consideration in the definition of the criteria for selecting infrastructure proposals given that women could have an interest in improved infrastructure insofar as it leads to better access to social services and time-saving, thereby helping them reduce domestic and childcare responsibilities. The schemes were decided based on the priority for rehabilitating the irrigation infrastructure without much reference to the nature of the target group benefitting. Similarly, the beneficiaries of the rural leasing activities were selected based on demand for leasing products which were targeted at the small and medium enterprises. None of the owners of the enterprises were women although women were employed with some of the enterprises. Given the particular context of Georgia, where gender equality and women's empowerment require serious attention, the project failed to make a notable contribution. *The project is rated as unsatisfactory (2) on this criterion.*

Environment and natural resources management

178. This impact domain involves assessing the extent to which the programme contributed to changes in the protection, rehabilitation or depletion of natural resources and the environment. The key natural resource at play in the project was water, which had clear implications for the environment. This is because, about 50 per cent of arable lands and 30 per cent of the grazing areas in Georgia are exposed to water and wind erosion. In addition, significant areas are subject to salinization and required drainage facilities.⁴⁶
179. The ASP investments in infrastructure did not cause any environmental degradation. The rehabilitated irrigation schemes were already existing schemes. As part of rehabilitation, some of the schemes were cleaned where earlier there was water clogging. The availability of a supplemental source of irrigation is going to help the smallholder farmers better cope with the risks of low rain fall and deal with the uncertain weather patterns.
180. Financing of the agriculture sector through rural leasing is unlikely to have any negative impact on the environment. This is premised on the assumption that, according to the PCR, all new constructions either in food processing, wine making, poultry production or greenhouse construction are required to get the requisite environmental clearance from the local authorities.
181. However, the project design *per se* appears to have paid little attention to environmental and natural resources management. The cooperation between IFAD and the Amelioration Company could have laid the groundwork for better use of natural resources especially related to watershed management. The Government's extension services could have been employed for this purpose. Given that little evidence suggests that this relationship was used to promote environmental and natural resource sustainability, it represents a missed opportunity.

⁴⁶ ASP Final Project Design Report, Working Paper 2: Small Scale Rural Infrastructure.

182. Further, the rehabilitation of canals likely reduced the wastage of water, but did not eliminate it. Results of FGDs and PPE mission's interviews with farmers (beneficiaries) suggest that leakage remained a problem. This, in conjunction with the lack of water use management is amongst the reasons why water availability is reduced in some rehabilitated canals during June and July which is the peak period before harvest and when most rehabilitated canals run dry.
183. The project can be considered *moderately unsatisfactory (3)* in this impact domain. Insufficient focus on this domain represents a missed opportunity.

Adaptation to climate change

184. Georgia is quite fragile towards natural disasters caused by climate change. In the last decade, Georgian mountainous regions, such as Mtskheta-Mtianeti, Racha-Lechkhumi, Achara and Guria, have been affected by natural disasters.⁴⁷ With the country experiencing warmer days and nights, more variable precipitation, and more frequent and intense climate events, there is clearly a need to reduce the risks to agriculture so as to make the sector more resilient. The investments made by the project ensured the rehabilitation of irrigation canals in order to provide water to smallholders, although a more reliable water supply would have ensured better adaptation to the ill effects of climate change.
185. Adaptation to climate change was not explicitly part of the project design: it did not envision any climate mitigation or adaptation measures. However, given the variability in precipitation levels experienced by Georgia, an important aspect of adaptation to climate change should have been the emphasis on better management of irrigation water by beneficiaries. This represents a missed opportunity, especially since an earlier IFAD project, the Rural Development Programme for Mountainous and Highland Areas, had taken adaptation to climate change into consideration in its design. This impact evaluation rates adaptation to climate change as *moderately unsatisfactory (3)*, one below the rating provided in the PCR.

C. Overall project achievement

186. The project's achievement can be described as mixed. Some of the original objectives and activities were modified whilst some of the original ones were not achieved. The activity of rehabilitating irrigation canals was undertaken as per plan and was successful in bringing irrigation water to the beneficiaries, although, the regularity of water supply remained an issue. Insofar as longer term development goal of increased incomes is concerned, the fact that the irrigation schemes were rehabilitated relatively late into programme implementation could have affected the lack of noticeable results at the time of this evaluation. Construction of bridges facilitated safe movement of livestock to summer pastures whilst drinking water pipes brought water to the homes of the intended beneficiaries.
187. The project reached out to rural enterprises with loans for financing their leasing needs dispensed through a leasing company, with direct beneficiaries expressing satisfaction of the project's intervention. The biggest setback though was under-achievement with regard to the leasing component, specifically related to MFIs. The MFIs did not come on board, for reasons outlined in this report, considerably reducing the outreach and the effectiveness of the leasing component. Attention was paid to gender at design stage through gender-specific targets but the lack of a gender strategy meant that no overt attempts were made to bring women into the fold of the project.
188. In conclusion, looking at the results as they stand today, the lack of the project's achievements in some respects, and its under-achievements in others, outweigh its

⁴⁷ Between 1995 and 2011 the total amount of damage occurred in consequence of geological and hydro-meteorological natural disasters amounted to GEL 2,338 million, according to the National Environmental Agency of the Ministry of Environment Protection of Georgia (source: *Georgia Today*, 16 July 2015).

achievements, and the evaluation rates overall project achievement as *moderately unsatisfactory* (3).

D. Performance of partners

Government of Georgia

189. The Ministry of Agriculture's decision to liquidate the ADPCC, which had responsibility for the overall management and implementation of previous IFAD and World Bank co-financed projects, in order to mainstream project implementation within the Ministry⁴⁸ led to a virtual paralysis of project implementation (based on the stipulation under Georgian law that entities under liquidation are not allowed to enter into new contractual arrangements). Thereafter the International Organisation's Projects Implementation Department assumed responsibility for ASP implementation until the establishment of the Donor Projects Implementation and Monitoring Division within the External Relations Department of the Ministry.
190. These frequent changes led to a difficult transition for the project management unit due to loss of their earlier autonomy which had to be circumscribed in order to be mainstreamed within the overall systems of the Government of Georgia. Besides, as a result of the liquidation, a number of ADPCC/International Organisation's Projects Implementation Department staff of relevance to ASP management and implementation, including one of the two former ADPCC Civil Engineers and both ADPCC Procurement Specialists, left the ADPCC either during or after the liquidation.
191. To compound problems mentioned above with regard to the liquidation decree, considerable delay on part of the Government to approve the Operation Manual for Rural Leasing further affected all activities planned for 2011 as follows. First, the process of selecting the consultants for the due diligence of leasing companies and new MFIs to join the scheme was stopped as the Operations Manual was not approved and the ADPCC liquidation issue emerged. Second, the recruitment of consultants for the development of the new MIS software for the RDP and ASP-related refinancing operations was stopped when the liquidation of the ADPCC was announced. Third, it was agreed that as the workload was increasing, a third officer would be recruited to administer the RDP/ASP refinancing operations with commercial banks, MFIs and leasing companies. The recruitment process was also stopped when the ADPCC liquidation decree was issued.
192. In addition, the decision of the Government to focus ASP investments on the irrigation sector late into the project implementation phase, given its priority to rehabilitate the irrigation infrastructure in the country, was a political one. Also, the Government wished to implement the infrastructure projects in a contiguous manner, rather than to disperse rehabilitation activities in unconnected areas. All this impacted the earlier approach of an active engagement of the beneficiary households and enterprises in the process of scheme identification, design and supervision. The schemes were identified by the Amelioration Company, brought in to identify the irrigation schemes, and the extent of beneficiary participation in the identification of schemes was not always made clear. Several supervision missions noted the lack of beneficiary participation and recommended greater interaction with potential beneficiaries in scheme selection, design and operation.⁴⁹ Farmers that formed part of this evaluation's Focus Group Discussions, and of interviews conducted by the IOE mission, were not consulted in these meetings.

⁴⁸ According to IFAD's Country Program Issues Sheet (CPIS) 2016, Mainstreaming the functions of the ADPCC into the regular civil service of the Ministry of Agriculture was in line with the Paris Declaration on Aid Effectiveness.

⁴⁹ Although, the project staff had organized validation workshops with beneficiaries, municipalities, regional branches of the United Amelioration System Company of Georgia and informal water users prior to start of the construction works in most of the schemes.

193. After 2012, with a new national Government in place, the performance of the Government and the engagement of the Ministry of Agriculture with ASP became more consistent, due to the changes in Government policies, which considered agriculture as a priority sector. Amongst the other positives was the timely submission of the External Audit report to IFAD. Audit work throughout the project's life followed IFAD's Project Audit Guidelines.
194. The M&E system was established after two years of the project start. As a result, initially, Progress and Impact reports were not prepared adequately (PCR). However, in 2012, a staff member from the Ministry of Agriculture took responsibility for managing the M&E system and was oriented in the use of the RIMS system. Consequently, the baseline survey was carried out in 2012 and the endline on project completion. Although the lack of baseline at project start meant that no targets were set in the project log frame, the endline survey made good effort to assess project attribution by including both treated and untreated areas. RIMS reporting was on time and the project collected output data, included sex-disaggregated, on a regular basis. One of the issues with the data though was that system mainly reported on physical progress (Supervision Mission, 2015). The project aimed at increasing incomes of beneficiaries; however, in the log frame it is not mentioned of how many and by how much. One reason could be lack of baseline study at time of project start (before date of effectiveness). Until the supervision mission in 2012, the number of smallholder families that were expected to benefit from the two project components were not projected due to the fact that all the rural leasing and the specific irrigation schemes had been identified.
195. Amongst the positive features is the fact that in addition to the PCR prepared jointly with IFAD, the Government also prepared its own implementation report at the close of project which contained additional information (and which the Evaluation mission found useful for its work). Moreover, in some part, the Government of Georgia putting in strong leadership in the Amelioration Company, which is completely restructuring the organization and putting in place a system to deal with the key constraints, is also its acknowledgment to IFAD supervision and follow-up missions. These missions drew attention to the necessity for strengthening the capacity of the institutions in charge of operation and maintenance and consultation and participation of water users in the process of design, construction and scheme maintenance.
196. The Government's decision related to re-organization of the PMU, the delay in approval of the implementation manual and the selection of irrigation schemes lacking a systematic approach to participatory methods of scheme selection are aspects that were less than satisfactory. However, after 2012, the Government's active engagement and support to the project, and the fact that the continuity of the PMU was maintained with key staff who had experience of IFAD projects, are aspects that shed a better light on Government's commitment. On balance, this evaluation rates Government performance for the project as *moderately satisfactory (4)*.

IFAD

197. On its part, efforts were made by IFAD to actively collaborate with other development partners. The project had a natural advantage in collaborating with other donor agencies such as World Bank given that the project management of ASP was also responsible for the World Bank projects. Initially it was foreseen that USAID would collaborate with ASP in the rural leasing component by organizing capacity building opportunities for micro finance institutions. Since no microfinance institution was engaged in the leasing activities, the collaboration with USAID was dropped. Meetings were also held with Swiss Development Cooperation to learn from their investments in the agriculture sector in Georgia. On the other hand, the lack of active consultation with donors during the design and at the early stages of

implementation meant that the co-financing envisaged for the project did not materialize, and IFAD had to provide a supplementary loan of US\$5 million to make up the shortfall. Insofar as non-governmental organizations are concerned, the technical assistance component was not used effectively to engage with the MFIs in increasing their level of interest or capacity in leasing operations.

198. In terms of the project design, IFAD's initiative in drawing from past project experiences to avoid over-complex design and infrastructure sustainability issues by ensuring that responsibilities for infrastructure maintenance were established from the outset and a two component project was developed is acknowledged by this impact evaluation. However, the lack of assessment regarding some of the design assumptions can be questioned, in particular, the apparently ambitious estimate of the level of participation of both commercial leasing companies and MFIs within the rural leasing component. In addition, the want of objective specifications of the selection criteria for the leasing proposals at project design led initially to a delay in their approval. This was crucial since at project design, adherence to a strict time schedule in processing financing applications from PFIs had been considered to be paramount for maintaining their interest in the ASP.
199. IFAD regularly supervised the ASP with the supervision reports generally being very informative. Supervision by IFAD facilitated project implementation through changes in the financial allocation as well as modification of the implementation arrangements and better specification of the criteria for leasing proposals. During the midterm review, certain critical adjustments were made to streamlining the implementation of infrastructure rehabilitation and leasing activities, for instance, on the recommendation of one of the supervision missions, the project eventually adopted a scoring matrix to help facilitate decision making by a better assessment of the extent to which the proposed leasing projects met the IFAD objectives in terms of employment generation, creation of backward linkages to the smallholder and participation of women. However, the remaining implementation period was not enough to realize these changes fully.
200. The disbursements were generally made on time and approvals for the annual work plan and budget were given as soon as possible. To avoid delays in the start-up of rural leasing operations, IFAD ensured that the preparations for implementation started well before ASP effectiveness and with IFAD's technical support fielded early 2010, the draft Operations Manual and Subsidiary Loan Agreements for leasing companies and MFIs were drafted.
201. Although IFAD has good experience with small scale infrastructure interventions, its experience with agricultural leasing has an extremely limited base. Given this fact and that leasing was an innovation for IFAD in the Georgian context, the organization could have done more to understand the ground realities (for instance, anticipating the hesitancy on part of the MFIs to participate). The project Concept Note had mentioned that ASP will support the establishment of the legal framework for leasing arrangements, which did not materialize. The evaluation rates IFAD's performance as *moderately satisfactory (4)*.

E. Assessment of the quality of the Project Completion Report Scope

202. The PCR is on the whole well written, although it is devoid of a bibliography which makes it difficult to verify figures and statements made. All sections mentioned in the PCR guidelines have been adhered to. In terms of length, the PCR main body, at 25 pages is within the stipulated PCR guidelines of 19 – 26 pages. The scope of the report is largely comprehensive. The rating for scope of PCR is given as *satisfactory (5)*.

Quality

203. The PCR was prepared based on desk review of programme documentation, specific technical studies carried out during its preparation, RIMS data, impact evaluation study and consultation with programme stakeholders during workshop. It is on the whole lucid, although in some parts, the text appears repetitive. Similarly, although the PCRs provide a fairly good picture of project's achievements, the presentation is more output than outcome oriented. The stakeholder workshop did not include any beneficiaries and hence the key findings emanating therefrom, and used by the PCR, are not based on views of beneficiaries.
204. Some annexes are not referred to sufficiently in the main body of the document to capture their significance. Some statements made in the PCR were found to be incorrect. For instance, the PCR states that IFAD made several attempts to strengthen the institutional capacity in the irrigation sector, helping the Amelioration Company test different models of user participation and cost recovery. This could not be confirmed as per key informant interviews by the IOE mission. Finally, there is an overall lack of deeper analysis of results (for instance, what explains the low participation of women, in the section on effectiveness there is no discussion around results of bridges and drinking water sub-components). The rating is given as *moderately satisfactory (4)*.

Lessons

205. The PCR presents component-wise lessons learnt which is an informative way of presenting, and enumerates a wide variety of lessons. These are pertinent and valid, and some resonate well with this Evaluation's own findings and analysis. The section presents aspects that were overlooked in the design phase and which were learnt during implementation. The PCR speaks about aspects that didn't go well and how these could be done differently. Whilst this is useful, including also perhaps some points on which project activities contributed most significantly to achieving set objectives and why is usually a good practice especially in regard to informing future operations in the country. Unfortunately, the section is silent with regard to gender, participatory approach of the project and the need to have M&E system up and running at project start. However, this notwithstanding, the Evaluation finds the lessons learnt to be thought-provoking and assigns a rating of *satisfactory (5)*.

Candour

206. The PCR assumes a candid demeanor. It provides a frank assessment of both positive and less positive aspects of the project design and implementation, even though the general impression is of a report that veers more towards critical analysis. However, there is a discernible disconnect between some of the ratings and related narratives. The rating is *moderately satisfactory (4)*.

IV. Conclusions and recommendations

A. Conclusions

207. **The project's premise was correct – that infrastructure bottlenecks were holding back the commercialization of agriculture in Georgia.** The vast majority of farmers in Georgia practice subsistence farming and the current state of rural infrastructure in one of the several constraints that impairs their ability to attain a level of commercialization. **The project's attempt to be novel by introducing an innovative form of financial product in the Georgian context is well acknowledged.** Making farm equipment more easily accessible to farmers would have been a logical step towards promoting commercialization. **The project has triggered some revitalised interest in agriculture, encouraging other agencies such as World Bank to scale up the neglected irrigation schemes.**
208. **The project did not achieve the expected impact on beneficiaries of its biggest component.** Impact analysis of the small scale infrastructure component where majority of the project funds were directed showed statistically insignificant results for several key variables of interest. Leasing component's indirect beneficiaries on the other hand showed positive results. A partially unrealistic design and late implementation were some of the reasons for the results. Most irrigation schemes were completed only towards the end of the project and leasing though MFIs did not occur.
209. **The project components were not integrated in a manner that would have produced the expected development results.** There were in total five sub-components and they were implemented in disparate geographic areas and they targeted different types of beneficiaries: farmers, agro-processing companies, employees of these companies, livestock owners and some communities in general (drinking water). A lack of synergy amongst them meant that their collective force required for achieving the desired development results was affected.
210. **The project's thrust of introducing innovative rural finance services was based on limited business case analysis.** The assumption implicit in the design – that there would be MFIs interested in leasing to groups of farmers and that they would have the necessary wherewithal and the capacity to do so – was not entirely valid. In addition, project preparation and appraisal failed to consult adequately with partners to determine the constraints and remedies involved in a proposed rural leasing component, and especially to enable the key involvement of MFIs in reaching target beneficiaries through group lending.
211. **The project had a justified concern for backward linkages but did not back it with an adequate strategy.** There was mismatch between the targeting strategy for backward linkages and its implementation. Some of the equipment leased was directed towards increasing production on the large companies' own lands and not towards sourcing from farmers. In addition, some of the lessees used financing to lease the kind of equipment that did not have any effect on indirect beneficiaries: in the form of increased employment or augmenting supplies from farmers.
212. **A big gap in the project was not synchronising the rehabilitation of irrigation schemes with the strengthening of the capacity of institutions** in charge of operation and maintenance and with the improvement of on-farm water distribution including the needed additional investments in the rehabilitation of secondary and tertiary irrigation systems, training support to farmers and their mobilization and organization into informal water user groups. Moreover, efforts to involve water users in the distribution and management of water were missing; little sense of user ownership has been engendered nor have water user groups been formed. Furthermore, the current heavily subsidized water charge of GEL 75

per hectare compared to a real cost of GEL 250 is certainly unsustainable, especially as the irrigated area and financial liability increases.

213. **Women's empowerment was an important goal but this was missed,** though this had been emphasized as a criterion for targeting. The project could have contributed positively towards improving the existing gender imbalance and low level of women's empowerment in Georgia but was unable to do so because no gender strategy was formulated. Although, the project had included as one of the leasing terms that lessee agro-enterprises create employment for women.

B. Recommendations

214. **Recommendation 1. Apply a holistic approach to infrastructure rehabilitation when attempting to achieve a measurable change in the lives of farmers.** Simply rehabilitating infrastructure may not necessarily change the economic condition of beneficiaries. At a minimum, providing appropriate support services in agricultural production and marketing should be built into the project design, especially if the aim is to move to commercialization. Similarly, **it is recommended to assess the institutional voids of the particular context when aiming for long-term sustainability of infrastructure.** The institutional demands of the project need to be matched to local institutional capacity. The lack of harmonization of an infrastructure intervention with the mobilization and organization of beneficiaries into temporary or permanent users' groups can weaken the anticipated longer-term benefits, especially where Government departments lack the necessary experience in participatory group formation. Experienced non-governmental organizations can be hired to assist in this process.
215. **Recommendation 2. Apply a longer term programmatic approach for infrastructure related interventions.** Some project start up delays after loan effectiveness are inevitable, and within a normal project five-year time-frame, substantial infrastructural construction will only be completed during the last two project years leaving little time to discern effects and to provide continued support services.
216. **Recommendation 3. Minimize the gap between the irrigation potential created and that utilized by promoting environment and natural resource management.** Providing technical assistance, training and awareness-raising in watershed management to support the capacity needs of those charged with implementing and maintaining irrigation schemes, and those of the beneficiaries, can provide the impetus for a more sustainable use of water.
217. **Recommendation 4. When introducing innovative products in the rural financial space, undertake analysis of both the demand and the supply sides to ensure that new products meet the needs of all concerned.** The project could have addressed the issue of operational modalities not being conducive to the legal and regulatory environment through gaining a more complete understanding of the requirements, restrictions and guidelines for leasing to MFIs, examining the extent to which they supported the project design. Similarly, for an innovative product, the design should evaluate the partners' risk appetite for taking up an innovative financial offering in rural areas, with this being a context that can be risky for financial products. Finally, estimation of demand for an innovative product should be based on rigorous ex-ante analysis and adequate consultations with partners and even with likely beneficiaries.

Basic project data

			Approval (US\$ m)		Actual (US\$ m)	
Region	Near East, North Africa and Europe	Total project costs	17.2		12.76	
Country	Georgia	IFAD loan and grant and percentage of total	13.5 (loan) ^c 0.2 (grant)	80%	10.34	81%
Loan number	802	Borrower	2.1	12%	1.46	11.5%
Financing type ^a	IFAD loan and grant, Government Beneficiaries	Beneficiaries	0.9	5%	0.46	3.6%
Date of loan signature	8 July 2010	Other sources:	0.5	3%	0.5	3.9%
Date of effectiveness	8 July, 2010	Number of beneficiaries (if appropriate, specify if direct or indirect)	15 793 (SSRI) 3 838 (leasing)	4 730 (SSRI) 1 646 (leasing)		
Loan amendments ^b	None	Loan closing date	31 March 2015		31 December 2015	
Loan closure extensions	i) 10 months up to June, 2015 ii) 3 months up to September 2015	Mid-term review			7 June 2013	
Country programme managers	Henning Pedersen Lorenzo Coppola Dina Saleh	IFAD loan disbursement at project completion (%)			76% (loan) 97% (grant)	
Regional director(s)	Khalida Bouzar	Date of project completion report			31 December 2015	

Source: GRIPS, IFAD Flexcube system, PCR.

^a There are four types of lending terms: (i) special loans on highly concessional terms, free of interest but bearing a service charge of three fourths of 1 per cent (0.75 per cent) per annum and having a maturity period of 40 years, including a grace period of 10 years; (ii) loans on hardened terms, bearing a service charge of three fourths of 1 per cent (0.75 per cent) per annum and having a maturity period of 20 years, including a grace period of 10 years; (iii) loans on intermediate terms, with a rate of interest per annum equivalent to 50 per cent of the variable reference interest rate and a maturity period of 20 years, including a grace period of five years; (iv) loans on ordinary terms, with a rate of interest per annum equivalent to 100 per cent (100 per cent) of the variable reference interest rate, and a maturity period of 15-18 years, including a grace period of three years.

^b However, a supplementary loan agreement was executed which provided additional financing of US\$5 million in view of the lack of a co-financier envisaged at appraisal.

^c Includes the supplementary loan of US\$5 million.

Definition and rating of the evaluation criteria used by IOE

Criteria	Definition *	Mandatory	To be rated
Rural poverty impact	Impact is defined as the changes that have occurred or are expected to occur in the lives of the rural poor (whether positive or negative, direct or indirect, intended or unintended) as a result of development interventions. <i>Four impact domains</i>	X	Yes
	<ul style="list-style-type: none"> Household income and net assets: Household income provides a means of assessing the flow of economic benefits accruing to an individual or group, whereas assets relate to a stock of accumulated items of economic value. The analysis must include an assessment of trends in equality over time. Human and social capital and empowerment: Human and social capital and empowerment include an assessment of the changes that have occurred in the empowerment of individuals, the quality of grass-roots organizations and institutions, the poor's individual and collective capacity, and in particular, the extent to which specific groups such as youth are included or excluded from the development process. Food security and agricultural productivity: Changes in food security relate to availability, stability, affordability and access to food and stability of access, whereas changes in agricultural productivity are measured in terms of yields; nutrition relates to the nutritional value of food and child malnutrition. Institutions and policies: The criterion relating to institutions and policies is designed to assess changes in the quality and performance of institutions, policies and the regulatory framework that influence the lives of the poor. 		No
Project performance	Project performance is an average of the ratings for relevance, effectiveness, efficiency and sustainability of benefits.	X	Yes
Relevance	The extent to which the objectives of a development intervention are consistent with beneficiaries' requirements, country needs, institutional priorities and partner and donor policies. It also entails an assessment of project design and coherence in achieving its objectives. An assessment should also be made of whether objectives and design address inequality, for example, by assessing the relevance of targeting strategies adopted.	X	Yes
Effectiveness	The extent to which the development intervention's objectives were achieved, or are expected to be achieved, taking into account their relative importance.	X	Yes
Efficiency	A measure of how economically resources/inputs (funds, expertise, time, etc.) are converted into results.	X	Yes
Sustainability of benefits	The likely continuation of net benefits from a development intervention beyond the phase of external funding support. It also includes an assessment of the likelihood that actual and anticipated results will be resilient to risks beyond the project's life.	X	Yes
Other performance criteria			
Gender equality and women's empowerment	The extent to which IFAD interventions have contributed to better gender equality and women's empowerment, for example, in terms of women's access to and ownership of assets, resources and services; participation in decision making; work load balance and impact on women's incomes, nutrition and livelihoods.	X	Yes
Innovation and scaling up	The extent to which IFAD development interventions: <ul style="list-style-type: none"> (i) have introduced innovative approaches to rural poverty reduction; and (ii) have been (or are likely to be) scaled up by government authorities, donor organizations, the private sector and others agencies. 	X	Yes
Environment and natural resources management	The extent to which IFAD development interventions contribute to resilient livelihoods and ecosystems. The focus is on the use and management of the natural environment, including natural resources defined as raw materials used for socio-economic and cultural purposes, and ecosystems and biodiversity - with the goods and services they provide.	X	Yes
Adaptation to climate change	The contribution of the project to reducing the negative impacts of climate change through dedicated adaptation or risk reduction measures	X	Yes

<i>Criteria</i>	<i>Definition</i> *	<i>Mandatory</i>	<i>To be rated</i>
Overall project achievement	This provides an overarching assessment of the intervention, drawing upon the analysis and ratings for rural poverty impact, relevance, effectiveness, efficiency, sustainability of benefits, gender equality and women's empowerment, innovation and scaling up, as well as environment and natural resources management, and adaptation to climate change.	X	Yes
Performance of partners			
• IFAD	This criterion assesses the contribution of partners to project design, execution, monitoring and reporting, supervision and implementation support, and evaluation. The performance of each partner will be assessed on an individual basis with a view to the partner's expected role and responsibility in the project life cycle.	X	Yes
• Government		X	Yes

* These definitions build on the Organisation for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC) Glossary of Key Terms in Evaluation and Results-Based Management; the Methodological Framework for Project Evaluation agreed with the Evaluation Committee in September 2003; the first edition of the Evaluation Manual discussed with the Evaluation Committee in December 2008; and further discussions with the Evaluation Committee in November 2010 on IOE's evaluation criteria and key questions.

Rating comparison^a

<i>Criteria</i>	<i>Programme Management Department (PMD) rating</i>	<i>Project Performance Evaluation rating</i>	<i>Rating disconnect</i>
Rural poverty impact	5	3	-2
Project performance			
Relevance	4	4	0
Effectiveness	4	3	-1
Efficiency	4	3	-1
Sustainability of benefits	5	4	-1
Project performance^b	4.25	3.5	-0.75
Other performance criteria			
Gender equality and women's empowerment	3	2	-1
Innovation	4	3	-1
Scaling up	5	4	-1
Environment and natural resources management	5	3	-2
Adaptation to climate change	5	3	-2
Overall project achievement^c	5	3	-2
Performance of partners^d			
IFAD	5	4	-1
Government	5	4	-1
Average net disconnect			-1.17

^a Rating scale: 1 = highly unsatisfactory; 2 = unsatisfactory; 3 = moderately unsatisfactory; 4 = moderately satisfactory; 5 = satisfactory; 6 = highly satisfactory; n.p. = not provided; n.a. = not applicable.

^b Arithmetic average of ratings for relevance, effectiveness, efficiency and sustainability of benefits.

^c This is not an average of ratings of individual evaluation criteria but an overarching assessment of the project, drawing upon the rating for relevance, effectiveness, efficiency, sustainability of benefits, rural poverty impact, gender, innovation and scaling up, environment and natural resources management, and adaptation to climate change.

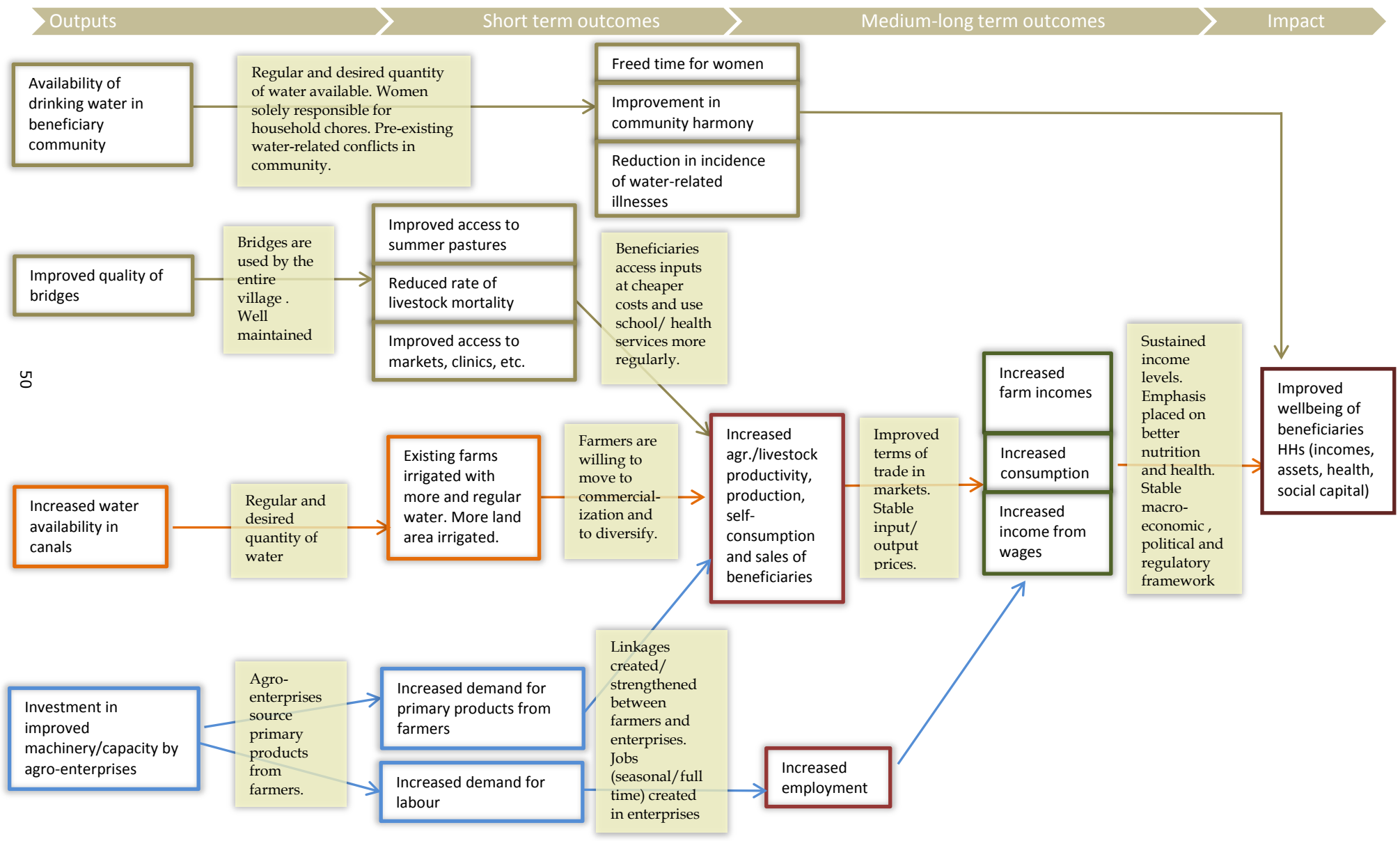
^d The rating for partners' performance is not a component of the overall project achievement rating.

Ratings of the Project Completion Report quality

	<i>PMD rating</i>	<i>IOE rating</i>	<i>Net disconnect</i>
Scope	5	5	0
Quality (methods, data, participatory process)	5	4	-1
Lessons	5	5	0
Candour	5	4	-1

Rating scale: 1 = highly unsatisfactory; 2 = unsatisfactory; 3 = moderately unsatisfactory; 4 = moderately satisfactory; 5 = satisfactory; 6 = highly satisfactory; n.a. = not applicable.

Reconstructed project theory of change



Project logical framework

Narrative summary	Impact/result indicators	Means of verification	Assumptions/risks
<p>Goal</p> <p>The project goal is to reduce rural poverty in Georgia</p>	<p>Impact indicators</p> <ul style="list-style-type: none"> Reduction in percentage of rural people living on US\$2/day Increase in rural household capital assets Reduction in chronic malnutrition among children below five years of age 	<p>DS and LSMS data Ministry of Health, WHO and World Vision malnutrition surveys Project M&E database Mid-term and completion assessments</p>	<p>Political stability Macro-economic environment remains conducive to investment, private sector development, and trade Corruption is contained and its impact on commerce reduced</p>
<p>Purpose/objective</p> <p>The project's objectives are: (i) to increase assets and incomes among actually and potentially economically active poor rural women and men willing to move towards commercially viable agricultural and associated rural enterprises; and (ii) to remove infrastructure bottlenecks which inhibit increasing participation of economically active rural poor in enhanced commercialization of the rural economy</p>	<p>Result indicators</p> <ul style="list-style-type: none"> Value of incremental revenue of primary producers Increase in incomes of agro-related employees Number of on and off farm new jobs created per US\$1 000 investment through leasing contacts and improved infrastructure Increase in public and private commercial investments Increase in volume, value, quality and diversity of agro-related trading 	<p>Mid-term and completion assessments Beneficiaries assessments Ad hoc case studies ADPCC and PFI records Other Government agriculture/trade Data</p>	<p>Absence of large external economic shocks. No deterioration in internal trade regulations and procedures Government commitment and understanding of the project Development and diversification of domestic and international markets</p>
<p>Outputs from components</p> <p>Support for rural leasing</p> <p>The recapitalisation and consequent modernisation of Georgian agriculture, specifically among poor smallholders and small and medium agro-related enterprises as a result of the introduction and expansion of rural leasing as a flexible and affordable financial instrument</p>	<p>Result indicators</p> <ul style="list-style-type: none"> Type, number and value of leasing contracts Number and type of PFIs Production/productivity gains among lessees Income and capital asset gains among lessees 	<p>Mid-term and completion assessments Ad hoc case studies ADPCC and PFI records Export/import statistics</p>	<p>No major adverse developments in financial sector stability in Georgia External markets for Georgian agro-products diversified or reopened after the 2008 conflict and import substitution policies in place</p>

Narrative summary	Impact/result indicators	Means of verification	Assumptions/risks
Outputs from components	2nd level result indicators		
Small-scale rural infrastructure (SSRI)	<ul style="list-style-type: none"> • Area of rehabilitated or established irrigated land • Water delivered compared to water requested • Km of rural roads rehabilitated • Number and type of other ASP-supported infrastructure • Number of functioning infrastructures after three years • Number and type of created or expanded businesses as a result of developed infrastructure • Incremental annual value of revenue of farmers/ enterprises served by infrastructure at establishment and after three years • Value of villagers contribution in support to infrastructure projects • Number of beneficiaries by type of rehabilitated/ developed infrastructure 	Contractors reports Mid-term and completion assessment Case studies PIU/ADPCC field visits and records Business plans and subsequent records Beneficiary focus group discussions	Transparent criteria applied for awarding of contracts Interest of Government and potential contracted processors to participate in the project
Project implementation			
Project effectively and efficiently managed	<ul style="list-style-type: none"> • Project physical and financial progress against final design and annual work plan and budget targets • Timely progress and financial reports submitted • Acceptable audits, procurement and financial reports 	ADPCC reports Annual work plan and budget Supervision missions IFAD follow-up missions	Efficient staff in ADPCC Procurement undertaken in a transparent and competent way
Inputs (US\$ million)	Financing (US\$ million)	Timing	
Support to rural leasing 4.9	The Government 2.1	Final design mission: June/July 2009	
Small-scale rural infrastructure 11.0	IFAD 8.7	Government review of final design report Aug/Sept 2009	
Project implementation 1.3	Clients/beneficiaries 1.4	Loan negotiations: Oct. 2009	
Total 17.2	Cofinancier (TBD) 5.0	IFAD Executive Board: Dec. 2009	
	Total 17.2		

Methodology used for undertaking the quantitative and qualitative analyses

1. **Mixed-methods approach.** The impact evaluation used a mix of both quantitative and qualitative methods in order to utilize the strengths, and overcome the shortcomings, of each of the two. These mixed methods are based on the principle of *method triangulation* i.e. the use of multiple methods to study a single problem or programme, such as interviews, observations, questionnaires or written secondary sources. The two methods can be carried out either contemporaneously or sequentially. In the case of this impact evaluation, these were undertaken in parallel, for reasons of cost and time efficiency.
2. Since the study is ex post, a panel is not possible, and since selection into the project could have been determined by unobservables, the problem of selection bias could remain. To overcome this, the evaluation relied on programme theory, as described earlier, to build an argument by plausible association, and relevant quantitative and qualitative methods, are described below. These methods were used to answer the key evaluation questions for the evaluation criteria and which form part of the evaluation framework.
3. The impact assessment used a quasi-experimental design in order to address the issue of endogeneity bias and to better attribute project results to the project interventions. Any identification of impact was achieved through a "counterfactual," i.e. what would have happened to a treatment group in the absence of the treatment.
4. Table 1 displays the quantitative and qualitative tools used in the evaluation. The core instrument for the evaluation was the household survey which was used to collect primary quantitative data. The survey was administered to 3190 households, with 1778 interviews in control households and 1412 in treatment households.

Table 1
Evaluation tools

<i>Quantitative tools</i>	<i>Purpose</i>
Structured impact survey	Administered to all the sampled households for the collection of primary quantitative data.
Focus group discussions	Conducted separately for women and men by project component and sub-component to triangulate with quantitative information.
Key informant interviews	Conducted with different project partners to identify project successes and failures particularly as relates to project performance and other performance criteria
In-depth interviews	Conducted separately for women and men by project component and sub-component to triangulate with quantitative information.

5. The quantitative part of the evaluation was complemented by a set of qualitative tools, which provided an understanding of the causal mechanisms by which the intervention either achieved or failed to achieve its goals. Table 2 provides the type and number of qualitative interviews conducted.

Table 2
Qualitative data collection

<i>Key respondent</i>	<i>Tool to be administered</i>	<i>Quantity</i>
Companies receiving lease	In-depth interview guide	11
Indirect beneficiaries of leasing	Focus group discussion	1
Bridge community members	In-depth interview guide	2
ASP staff, other donors, policy makers	In-depth interview guide	10
Drinking water community members	In-depth interview guide	2
Irrigation community members	Focus group discussion	3

6. The survey contained two strata. In the leasing component, 1,061 interviews were carried out with 686 control observations and 375 treatment observations. In the infrastructure component, 2,177 interviews were carried out, with 1,140 control observations and 1,037 treatment observations. Response rate came to 69 per cent in the infrastructure component and 41 per cent in the leasing component, including non-response due to non-eligibility.
7. Sample size. When determining sample size, the primary consideration is statistical power. Notably, from a statistical perspective, the ASP project activities treated clusters – individuals and households living in a specific area – rather than specific individuals and households. Hence, it is necessary to calculate effective sample size, taking into account the clustered nature of the treatments, rather than performing simple power calculations to determine the number of interviews required to achieve sufficient statistical power. For the present section, we base our calculations on the household income variable in the baseline survey ASP carried out, which is the variable likely to have the greatest amount of variance, and thus be most difficult to pick up impact on due to the nature of statistical power.
8. Effective sample size, which is calculated when treatments are cluster level, is determined by the following formula:

$$\text{effective } N = \frac{N}{1 + (n_j - 1)ICC}$$

N is the number of observations, n_j is the number of observations per cluster, and ICC is intraclass correlation. ICC is calculated using the following formula:

$$ICC \equiv \frac{\text{variance between clusters in } y}{\text{total variance in } y} \equiv \frac{\sigma_j^2}{\sigma_j^2 + \sigma_i^2}$$

9. Calculations of ICC the IOE team performed with the baseline and endline surveys IFAD carried out suggest an ICC between 0.0076 (baseline) and 0.024 (2012 recall data). Given that there were significant amounts of missing data in the 2015 survey, a more conservative ICC of 0.05 was also used when calculating Explained Sum of Squares. These calculations result in the following effective sample sizes for the 3,000 interviews which was considered the maximum possible given budgetary constraints at the outset of the project.

Table 3
Effective sample size

<i>Intracluster correlation</i>	<i>Effective sample size</i>
0.0076	2 335.162
0.024	1 579.715
0.05	1 044.177

10. In order to determine whether the above sample sizes would provide the evaluation team with sufficient power to pick up the expected effect size, we used the standard power calculation formula for randomized control trials, since previous studies suggest that the statistical power of matching methods is close to that of randomized control trials.¹ The formula is as follows:

$$n_B = \left(1 + \frac{1}{k}\right) \left(\sigma \frac{Z_{1-\alpha/2} + Z_{1-\beta}}{\mu_A - \mu_B}\right)^2$$

11. When calculating power, assumptions of standard error levels of alpha=0.05, beta=0.20, and a ratio of 1.4 observations in the control to treatment groups were used. The group means and standard deviations are taken from the 2015 endline survey IFAD carried out on total household income.
12. The endline survey suggested a 2 per cent effect size on household incomes. While the ability to pick up this small of an effect size would be desirable, it is largely impractical as the table below suggests it would require more observations than were treated according to project documentation. Instead, we assume effect sizes of 10 per cent, 20 per cent, and 30 per cent. Given that the project has been completed for a full year, thus giving time for effects to increase and that other studies in the region have shown effect sizes as large as 30 per cent, the larger effect sizes are both reasonable and practical. The table below presents required sample sizes for a 2 per cent, 10 per cent, 20 per cent, and 30 per cent effect sizes.

Table 4
Sample size needed to detect a given effect size

<i>Effect size</i>	<i>Sample size</i>
2%	35 296
10%	1 412
20%	353
30%	157

13. The above table suggests that the 3000 person sample is sufficient to pick up a 10 per cent effect size under the observed ICCs and a 20 per cent and 30 per cent effect size under much higher ICCs than observed in the baseline and endline surveys.
14. **Sampling strategy.** The evaluation used a multi-stage, matched sampling methodology to identify the individuals to be interviewed for the household survey. First, clusters were sampled. Second, at the village level, random walk with a random starting point was used. Then, in irrigation and leasing communities a

¹ See Sin-Ho Jung, Shein-Chung Chow & Eric M. Chi (2007) A Note on Sample Size Calculation Based on Propensity Analysis in Nonrandomized Trials, Journal of Biopharmaceutical Statistics, 17:1, 35-41, DOI: 10.1080/10543400601044790.

screeener questionnaire was used. While these overarching strategies were implemented, a number of different strategies were employed in sampling for the different project components, which are described in greater depth below.

15. *Sampling clusters for the infrastructure component.* A matched sampling strategy was used for the sampling of clusters in the infrastructure component. As a sampling frame, the list of all predominantly rural electoral precincts in Georgia was used. Based on a list of where project activities took place obtained from the IFAD country office, clusters were marked as treated or potential controls. Next, natural difference in vegetation index (NDVI), gender composition of the adult population, population size, Koppen Climate Classification, settlement type, predominant language spoken (a proxy for ethnicity in Georgia), among a number of other variables were organized in the sampling frame. A genetic matching algorithm was used to calculate weights for each covariate and a matching algorithm was then used to identify the most similar communities to the treated communities in 2012, prior to treatment. In total, 27 treatment clusters² and 27 control clusters were selected.
16. *Sampling individuals.* To sample individuals in treated communities, the random walk method was used and interviews were conducted with the self-identified most informed member of the household. Although random walk is less than ideal in many cases, because interviewers are often reluctant to visit remote households and simulations show that every household does not have an equal probability of being sampled in some cases, it is the best available solution for sampling in Georgia. This stems from the lack of practicable alternative sampling methods.
17. Ideally, the survey would use simple random sampling of households. However, the National Statistics Office does not release a full list of individuals or households in the country due to data protection legislation which is interpreted to include individuals' addresses. Alternative sampling frames such as the list of electricity customers, while largely complete, are not publicly available in Georgia as they are in Armenia. This means that a simple random sample of households is not possible.
18. Another possible sampling methodology would be to take satellite imagery of each cluster, super-impose a grid on it, and then randomly select quadrants. There are three primary issues with this methodology. First and foremost, it is not always possible to identify whether a building is a household or a barn, storage facility, business, or other building from a satellite image. Thus, sampling frames include non-households with this methodology when used in Georgia. Second, this methodology runs into the same issues that arise with random walk as well as additional ones when it comes to interviewer management. With this methodology, interviewers are given maps and GPS and then instructed to find the household. The lack of addresses in rural areas of Georgia means that they are not able to simply go to an address. Given the margin of error on the GPS on available tablet computers, they may be unable to accurately identify a household. In some cases, this may lead to interviewers engaging the wrong household. Third, in addition to these practical issues, there are also significant financial costs associated with the gridded sampling strategy, because it requires the mapping and gridding of every cluster. This requires a significant amount of work from a geographer and sampling specialist not planned for at the proposal phase of the project.
19. Another potential sampling methodology is the use of community mapping. In community mapping, an interviewer goes to the head of a community and maps out the households in the communities. However, this strategy is not feasible in Georgia for a number of reasons. First, the size of rural communities varies from roughly 30 households to several hundred. In the smaller areas, it would be feasible for a community leader to be talked to, however, in the larger

² Although project documentation shows a higher number of treatment villages, in some cases multiple treatment villages were contained within a single cluster.

communities, knowing several hundred households would be unlikely, leading to problematic sampling frames. Second, in many Georgian communities, there will not be any individual who can be clearly identified as a community leader, besides potentially the head of a village council. Heads of village councils are politicians, and may have their position due to political connections rather than thorough knowledge of their communities. Notably, community mapping would have also incurred additional project costs and led to delays in fieldwork.

20. Given that the above sampling strategies are inappropriate for the Georgian context, a random walk was used. In order to help address the deficiencies of random walk, random selection of starting points was made from a list of map identifiable points.
21. During the random walk, in irrigation sub-component clusters, a screening question was applied in order to identify programme beneficiaries. The screener questionnaire was used based on the experience of the pilot survey, during which a random walk only found one irrigation user. Screener questionnaires were not used in either of the other infrastructure cluster types, because the treatments were more reasonably cluster-level (i.e. a bridge is expected to be used by all members of the community and the enhanced drinking water supply was also expected to be used by all members of the community).
22. *Sampling for the leasing component.* At the outset of evaluation, the above strategy was planned for use in both the leasing and infrastructure components. However, after coming to understand that there was no accurate list of where indirect beneficiaries lived or a list of indirect beneficiaries (the target population in the leasing component's case), an updated strategy was necessary. Hence, the Caucasus Research Resource Center reconstructed the supply chains of a number of leases in the wine industry. The wine businesses were selected since 1) a plurality of businesses that received leases were wine producers 2) the wine businesses were the most willing to provide lists of their suppliers 3) grape production is often geographically clustered and control observations could be drawn from the same communities. For control observations, clusters were the same as those of treated individuals. Since leasing is not expected to be a cluster-level treatment for indirect beneficiaries in relatively diffuse supply chains individuals were selected from the same communities.
23. Based on the lists of suppliers the wine companies provided, Caucasus Research Resource Center contacted every grape grower on the list and interviewed all that agreed to be interviewed. To form a control group, in the same communities, interviews were carried out with grape growers who sold grapes or made wine and did not sell them to any of the companies which received leases. These individuals were identified through random walk and a screening questionnaire. In cases when the random walk uncovered individuals who sold grapes to the lease companies, they were interviewed as part of the treatment group.
24. **Quantitative data analysis methods.** The impact evaluation mainly made use of DID analysis. DID essentially compares treatment and comparison groups in terms of outcome changes over time (2016 in this case) relative to the outcomes observed for a pre-intervention baseline (2012 in this case). That is, given a two-period setting where $t = 0$ before the programme and $t = 1$ after programme implementation, letting Y_t^T and Y_t^C be the respective outcomes for a programme treated and non-treated units in time t , the DID method will estimate the average programme impact as follows:

$$DID = E(Y_1^T - Y_0^T | T=1) - E(Y_1^C - Y_0^C | T=0)$$

where $T_i = 1$ denotes treatment or the presence of the programme and $T_i = 0$ denotes untreated areas.

25. In the DID analysis, the driving idea is to use counterfactual logic to understand what would have happened in the communities which received interventions had the intervention not taken place. Given that ASP did not make use of randomization, a two staged matching procedure was used to achieve balance on observable variables. First, treated communities were matched with non-treated communities on a number of variables, as described above. Second, after data collection households were matched using multivariate matching with genetic weights. Finally, when feasible, a differences in differences approach was used, with incremental changes used as an outcome variable rather than only the 2016 outcome. The use of this strategy is expected to increase precision of estimates as well as increase robustness to confoundedness. Regression analyses were then used to estimate causal effects.
26. For with without analysis, matching of beneficiaries with control observations was carried out as a form of data pre-processing, with several matching options tested.³ In all cases, matching started with propensity score calculation. Propensity scores were calculated based on socio-demographic variables but also on a number of baseline characteristics relevant to the nature of the project's interventions including:
- (i) Whether the household was headed by a male or female;
 - (ii) Average age of the household;
 - (iii) Age of the household head;
 - (iv) Number of household members;
 - (v) Education type (no primary education, primary education, incomplete secondary education, secondary education, secondary technical education, higher education, incomplete higher education, graduate degree);
 - (vi) Ethnicity (Georgian, Armenian, Azerbaijani, other Caucasian ethnicity, Russian);
 - (vii) Religion (Armenian Apostolic Christian, Georgian Orthodox Christian, Catholic, Other type of Christianity, Muslim);
 - (viii) Land ownership in 2012;
 - (ix) High value crop growing;
 - (x) Staple crop growing;
 - (xi) Irrigation user in 2012;
 - (xii) Land owned and used for agriculture in 2012.
27. For religion, education type, and ethnicity, dummy variables were used in the matching algorithm. In total, including all dummy variables, 29 variables were used for matching each sample.⁴
28. After calculating propensity scores, genetic matching was carried out. Genetic matching is a generalization of propensity score and mahalanobis distance matching.⁵ In genetic matching, weights are calculated for each covariate. The use of such weights optimizes balance on covariates in the matched sample. This is important as the purpose of matching is to attain balance on covariates between treatment and control groups. Generally speaking, only genetic matching and

³ See Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth A. Stuart. "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." *Political Analysis* 15, no. 03 (2007): 199-236. doi:10.1093/pan/15/3/199.

⁴ These include the entire project, leasing component beneficiaries, infrastructure component beneficiaries, drinking water sub-component beneficiaries, irrigation rehabilitation sub-component beneficiaries, bridge rehabilitation sub-component beneficiaries, and female headed households in all project components.

⁵ See Diamond and Sekhon, 2013: http://www.mitpressjournals.org/doi/abs/10.1162/REST_a_00318#.WRWeQoiGPDc.

coarsened exact matching are designed for balance optimization. In contrast, propensity score matching does not optimize balance, and leading methodologists suggest that propensity scores alone should not be used for matching.⁶ In contrast to genetic matching, coarsened exact matching usually results in larger losses of statistical power, dropping observations from both the treatment and control groups. Moreover, coarsened exact matching is only appropriate in specific circumstances. Hence, genetic matching was selected as the matching method for the evaluation. Notably, case studies as well as simulations support the contention that genetic matching generally outperforms propensity score matching.⁷

29. Although genetic matching generally outperforms propensity score matching, to test whether it did in the present case, match balance was tested for the samples matched on propensity scores. The genetic matching process led to greater balance on covariates. In cases where balance was not achieved on observables with the full dataset, calipers were applied to increase balance between treatment and control groups. In matching, calipers set a maximum distance allowed between two observations which are matched with each other. For instance, if a control observation had a propensity score of 0.8 and another individual had a propensity score of 0.5, they could be matched if the caliper was set at 0.5, because the difference between them (0.3), is less than 0.5. However, if the caliper was set to 0.2 then, these individuals would not be matched, because the distance between them is larger than 0.2. In essence, calipers set a limit to how different the observations in treatment and control groups can be. At the same time, they often reduce the sample size of the matched dataset, meaning less statistical power. Hence, calipers were used only insofar as statistical power remained sufficient.
30. Regressions appropriate to the outcome variable type were then used to estimate causal effects of treatments. Since the independence of observations could not be assumed, clustered standard errors were then calculated. Estimates are reported with the p value which resulted from taking into account clustered standard errors.

⁶ Gary King and Richard Nielsen. Working Paper. "Why Propensity Scores Should Not Be Used for Matching". Copy at <http://j.mp/2ovYGsW>.

⁷ <http://worldcomp-proceedings.com/proc/p2011/BIC3060.pdf>.

Geospatial analysis of project impact

1. **Methodology.** The present pilot study applied an innovative Earth Observation methodology in supporting the project impact evaluation in Georgia, with a focus on the impact of irrigation rehabilitation on agricultural production. The methodology is derived from the before/after control/impact 'BACI' contrast.¹
2. The methodology consists of a comparative method that analyses the temporal variations (before and after the intervention) of the NDVI² of the intervention area with respect to multiple control sites that are automatically and randomly selected from a set of candidates that are similar to the intervention area. The rationale is that the intervention will cause a different pattern of change from before to after the intervention compared with similar areas not affected by project interventions. This concept forms the basis of the BACI sampling design applied in this analysis. The method output is an estimate of the magnitude and significance of the difference in greenness change between the intervention area and control areas.
3. With respect to the project area (PA), a control area (CA) should have the following characteristics:
 - (i) similar land cover;
 - (ii) relatively close in space in order to reduce difference due to external factors (climate, soil, agronomy, etc.);
 - (iii) not subjected to intervention during the whole before–after period being analysed;
 - (iv) randomly selected.
4. The analysis has been performed on freely available satellite images: 250-m NASA MODIS NDVI product (8 days) from 2003 to 2016. The methodology was completely automatized by developing an algorithm in open source statistical software R (R Development CoreTeam, 2016). The variable considered is the maximum seasonal value of smoothed NDVI. The study areas are the five irrigation schemes where project intervention took place i.e. schemes that were rehabilitated by the project viz., Does-Grakali, Lami-Misaktsieli, Karagaji, Metehki, Dzevera-Shertuli.
5. The first step consisted in analysing 14 years dataset and calculating the multi-annual vegetation development profile on which to run an unsupervised classification (KMeans cluster analysis) allowing to determine the period of vegetation growth and classify the area according to different vegetation development patterns. Only the cluster classes present in the area of intervention (similar land cover and vegetation development patterns) were considered eligible for the analysis. The period of vegetation growth roughly ranges from April to September, with maximum development reached in early July.
6. The second step consisted in assessing the similarity between pixel in the CA and in the PA. Similarity was defined as the complement of the Root Mean Squared Error (RMSE) between the fractional compositions and one, i.e. similarity $s = 1 - \text{RMSE}$. Values close to one thus indicate nearly identical overall composition of a CA and the PA. Then the pixel population of potential CA were subsampled by discarding those with a similarity smaller than 0.9. At this point, a sample of potential CA that fulfilled conditions i to iii was collected.
7. In the next step, 50 CAs were randomly extracted and then the NDVI was computed for all valid pixels belonging to the PA and CA for the period before and after the intervention. The 20 CAs with higher RMSE were considered for the

¹ Presented in the research paper: *Remote sensing monitoring of land restoration interventions in semi-arid environments with a before–after control-impact statistical design*, Meroni et al. 2017.

² Normalized Difference Vegetation Index (NDVI) is an index of plant “greenness” or photosynthetic activity.

calculation of the BACI contrast. Finally, in the last step, the impact of the intervention was evaluated by the interaction of the period and the site class (the so-called BACI effect) representing the differential change between PA and CA compared before and after the intervention.

8. The before and after time-frame considered in the analysis is different for each irrigation scheme based on the year of project intervention finalisation. A three year period was considered for the period before intervention.
9. The (null) hypothesis of no change was rejected at the conventional 5 per cent significance level. The BACI analysis provides two important statistics: the significance level (P-value) of the BACI effect test and the BACI contrast. The BACI contrast is calculated as the difference (CA vs. PA) between the mean differences (after vs. before):

$$\mathbf{BACI\ contrast = (\mu CAa - \mu Cab) - (\mu PAa - \mu PAb)}$$

where μ is the site-specific spatial mean of the variable selected to represent the impact (here NDVI); CAa, PAa stand for control area and project area 'after', respectively; CAb and PAb stand for control area and project area 'before', respectively.

10. By convention, a negative BACI contrast indicates that the variable has increased more (or decreased less) in the intervention site with respect to controls in the time period ranging from before to after the implementation of the project. The BACI contrast is expressed in the same units of the variable of interest, here NDVI. In order to highlight the magnitude of the contrast with respect to the initial conditions, it was normalised by the mean of the NDVI of the impact area before the intervention took place and express it as a percentage. This derived variable is referred to as "relative contrast".
11. For each of the rehabilitated perimeters (PA) the analysis has been carried out on the entire area of intervention and on some sub-samples according to three different field sizes assumed as small (< 2ha), medium (2-10ha) large (> 10ha).
12. **Results.** The results of the BACI analysis using MODIS NDVI are reported in following table.

BACI results on MODIS (250 mt) maximum NDVI (Apr-Sep)

<i>Perimeter name</i>	<i>Zone</i>	<i>BACI index (contrast)</i>	<i>Relative contrast %</i>	<i>P-value</i>	<i>Before and after Time-frame</i>
Does-Grakali	full area	-0.0052	-0.73	0.0080061	2011-13vs2014-16
Does-Grakali	medium fields	-0.0155	-2.16	0.0002820	2011-13vs2014-16
Does-Grakali	small fields	-0.0067	-0.89	0.2066130	2011-13vs2014-16
Lami-Misaktsieli	full area	0.0024	0.34	0.0000150	2011-13vs2014-16
Lami-Misaktsieli	large fields	-0.035	-4.9	0.0892510	2011-13vs2014-16
Lami-Misaktsieli	medium fields	0.0203	2.89	0.0000470	2011-13vs2014-16
Lami-Misaktsieli	small fields	0.0036	0.48	0.0004710	2011-13vs2014-16
Karagaji	full area	0.0216	2.98	0.0001090	2012-14vs2015-16
Karagaji	small fields	-0.0031	-0.41	0.0058530	2012-14vs2015-16
Metehki	full area	0.0065	0.85	0.2082250	2012-14vs2015-16
Metehki	small fields	-0.0113	-1.45	0.0001110	2012-14vs2015-16
Dzevera-Shertuli	full area	0.0043	0.61	0.0145280	2013-15vs2016
Dzevera-Shertuli	medium fields	0.0595	9.24	0.3925540	2013-15vs2016
Dzevera-Shertuli	small fields	-0.0044	-0.63	0.0140050	2013-15vs2016

13. Results show a significantly negative BACI contrast (i.e. improvement in NDVI with respect to CA after the intervention) was detected in 7 out of 14 samples respectively but only 4 have a significant 0.05 P-value.
14. Focussing on the sites for which a significant BACI effect was detected, the average relative contrast is -1.24 per cent. Considering NDVI as a rough approximation of the fractional vegetation cover, these numbers translate into a limited improvement in the vegetation development with respect to the controls.

Variable descriptions

1. This annex presents descriptions of the variables used in the impact evaluation and provides the mean and standard deviation of each statistic for each matched sample.

Table 1
Descriptions of the variables

<i>Variable name</i>	<i>Description</i>	<i>Survey question(s)</i>
Household agricultural income	This variable is self-reported household income from agricultural activity, not including labour for other individuals in the agricultural sector. Heads of household were requested to report the amount their household took in from a number of sources. If the respondent did not report agricultural income a 0 was recorded. If the respondent reported that they did not know or refused to answer, then the observation was dropped for analysis. The differences in differences number was used for the outcome variable, which entailed subtracting the 2012 value from the 2016 value.	9, 10, 18, 19
Household non-agricultural income	This variable is the sum of all incomes in the household from employment, including self-employment and money taken in from a business.	2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17
Inflation adjusted bottom quartile of household income	This variable is the sum of the above two variables (household agricultural income and household non-agricultural income) adjusted for inflation. Between 2012 and 2016 consumer price inflation was 11.5 per cent. The 2012 value was transformed into 2016 constant Georgian lari. After the transformation of the variable into 2016 Georgian lari, the cut-off for the 2012 bottom quartile was calculated. Next, the number of individuals who moved out of the 2012 inflation adjusted bottom quartile by 2016 was calculated. Finally, a resulting dummy variable was used in logistic regression to test for an effect.	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19
Physical assets principal component	The physical assets principal component was calculated using the questions about whether individuals owned a given object and had purchased it after 2012. The principal component was calculated using the 16 objects that were asked about using dummy variables that had one if the individual purchased the object after 2012, and 0 marked if the individual purchased the asset before 2016. The principal component that had the highest correlation with the sum of assets was selected for analysis in order to ensure that the latent variable extracted corresponded to the physical assets. In all cases besides the bridge component, this was the first principal component. In bridge communities, this was the second principal component.	31a, b, c, d, e, f, g, h, i, j, k, l, m, n
Cows	This variable is the difference in number of cows that the household owned between 2012 and 2016.	93c, 94c, 99c, 100c
Calves	This variable is the difference in number of calves that the household owned between 2012 and 2016.	93d, 94d, 99d, 100d
Drinking water system type	This variable is marked as a one if the household changed their main source of water from one outside the house to one inside the house between 2012 and 2016.	22, 25, 26
Time to fetch drinking water	This variable measures the amount of time it took for individuals to fetch water and return home with the water. If individuals had a water system that piped water directly into their home, then the variable was marked as 0.	23, 25, 27
Dietary diversity	This variable was recorded on a 16 point scale and taken from the FAO's standard dietary diversity questionnaire. It is a measure of the dietary diversity of a household, the day before the survey. A 12 point scale was used collapsing the different foods into a number of dummies (e.g. meats).	123a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p

<i>Variable name</i>	<i>Description</i>	<i>Survey question(s)</i>
Spending on food	This variable is an ordinal variable, containing categories of spending from no expenditures to over GEL 2000. The question was asked about food spending the month prior to the survey.	119
Yields	This variable is the difference in agricultural yields between 2012 and 2016. Yields were only calculated if the individual grew a crop in both 2012 and 2016. Yields were calculated as the number of kilograms grown per hectare of land for each crop. Crop yields were calculated for potatoes, corn, onions, beans, apples, grapes, tomatoes and cucumbers, and plums and apricots based on the recommendation of the agriculture specialist working with the project team.	65, 66, 67, 73, 74, 75
Irrigated land	This variable is the difference in the amount of irrigated land between 2012 and 2016.	50, 60
Cultivated land	This variable is the difference between 2016 and 2012 in the total amount of land that the household grew crops on including land that was leased, rented, or borrowed.	35, 36, 42, 43
Food crop land	This variable is a variable with how much land the farmer is using for food crops in 2016 compared with 2012. Food crops constitute grains, corn, and beans.	65, 73
High value added crop land	This variable is how much land the household uses for high value added crops in 2016 compared with 2012. High value crops constitute tomatoes, cucumbers, onions, apples, plums, apricots, and grapes.	65, 73
Payment for irrigation water	This variable did not use the difference in difference approach, because impact was expected at the national level rather than only within irrigation communities. It is a dummy with 1 equal to paid for irrigation water and 0 did not pay for irrigation water. The question was only asked to individuals who used irrigation water from an irrigation system.	52, 61
Women's role in decisions related to asset purchases	This variable is a dummy with mainly the women of the household and both the women and men of the household response options marked as 1 and other response options marked as 0. It was only measured for 2016.	32
Women's role in decisions related to what agricultural products are produced	This variable is a dummy with mainly the women of the household and both the women and men of the household response options marked as 1 and other response options marked as 0.	117
Women's role in decisions related to which agricultural products will be sold or given away	This variable is a dummy with mainly the women of the household and both the women and men of the household response options marked as 1 and other response options marked as 0. It was only measured for 2016.	118
Women's role in decisions related to planting and taking care of the land	This variable is a dummy with mainly the women of the household and both the women and men of the household response options marked as 1 and other response options marked as 0. It was only measured for both 2016 and 2012 and a difference in difference approach was used in estimation.	39, 46

2. The table below presents the mean and standard deviation for the matched sample used for analysis of the impact of the irrigation subcomponent for each of the variables presented in the analysis in the main body of the report as well as its components (i.e. the 2012 and 2016 data).

Table 2
Irrigation matched sample descriptive statistics

Variable	Treatment group		Control group	
	Mean	Standard deviation	Mean	Standard deviation
Household agricultural income (change)	251.1132	2 757.713	115.4249	1076.367
Household agricultural income 2016	1194.165	4960.528	878.524	2290.675
Household agricultural income 2012	800.5789	2926.483	764.1235	1881.465
Household non-agricultural income (change)	1759.879	4429.038	1678.369	3741.28
Household non-agricultural income 2016	4851.143	5294.932	4637.651	6597.437
Household non-agricultural income 2012	3234.563	4589.265	3054.569	4512.113
Percentage above 2012 inflation adjusted bottom quartile in 2016	86%	0.3491078	84%	0.3639224
Average number of assets purchased after 2012	3.668689	2.795708	3.350728	2.709427
Dietary diversity	7.673544	2.21647	7.492718	1.935144
Spending on food last month (Percentage reporting GEL 250 or less)	60%	0.4896158	68%	0.467629
Irrigated land change	1774.389	8149.747	279.6405	1881.187
Irrigated land 2016	4875.461	8840.054	2841.756	4719.943
Irrigated land 2012	3143.383	5906.145	1891.759	3013.076
Cultivated land change	1009.331	29862.29	-243.732	6410.58
Cultivated land 2016	10840.54	38631.75	7100.508	11786.07
Cultivated land 2012	9337.462	39320.92	6746.671	11320.31
Food crop land change	1034.869	25348.761	151.3602	2559.291
Food crop land 2016	3481.521	24932.537	1486.037	4800.821
Food crop land 2012	2317.172	24589.631	1201.108	4953.519
High value added crop land	668.8663	19806.498	-0.34324	1937.103
High value added crop land 2016	1709.351	18177.464	679.0692	1848.574
High value added crop land 2012	1079.189	7720.853	686.0684	1863.569
Payment for irrigation water change (change)	33%	0.6132688	3%	0.2854268

3. The table below presents the mean and standard deviation for the matched sample used for analysis of the impact of the bridge subcomponent for each of the variables presented in the analysis in the main body of the report as well as its components (i.e. the 2012 and 2016 data).

Table 3
Bridge component matched sample descriptive statistics

Variable	Treatment group		Control group	
	Mean	Standard deviation	Mean	Standard deviation
Household agricultural income (change)	-230.769	2107.026	316.9014	1016.013
Household agricultural income 2016	475	1558.765	2676.744	1624.277
Household agricultural income 2012	589.7436	2425.17	2270.423	1410.004
Household non-agricultural income (change)	2668.373	5908.986	2652.698	3608.002
Household non-agricultural income 2016	6088.193	6634.253	6168.571	4802.142
Household non-agricultural income 2012	3462.882	5557.825	3515.873	3164.583
Percentage above 2012 inflation adjusted bottom quartile in 2016	78%	0.4174918	100%	0
Average number of assets purchased after 2012	3.94186	2.397816	3.348837	1.78073
Cows (change)	0.352941	3.191155	0.695122	1.411496
Cows 2016	2.647059	4.385327	1.034884	1.893939
Cows 2012	2.294118	4.358417	0.146342	0.5240382
Calves (change)	0.071429	1.454413	0	0
Calves 2016	0.905882	2.085229	0	0
Calves 2012	0.797619	2.525913	0	0
Dietary diversity	8.197674	2.184543	9.104651	1.389279
Spending on food last month (% reporting GEL 250 or less)	35%	0.4796781	10%	0.3078988

4. The table below presents the mean and standard deviation for the matched sample used for analysis of the impact of the drinking water subcomponent for each of the variables presented in the analysis in the main body of the report as well as its components (i.e. the 2012 and 2016 data).

Table 4
Drinking water matched sample descriptive statistics

Variable	Treatment group		Control group	
	Mean	Standard deviation	Mean	Standard deviation
Household agricultural income (change)	-35.579	597.1577	77.44444	885.8685
Household agricultural income 2016	113.4021	605.9821	434.0206	1694.2849
Household agricultural income 2012	306.0417	1796.045	382.5556	1031.778
Household non-agricultural income (change)	2615.638	3913.479	3235.529	6181.628
Household non-agricultural income 2016	7205.693	5315.313	6064.522	8566.078
Household non-agricultural income 2012	4923.389	4164.402	4363.231	5894.514
Percentage above 2012 inflation adjusted bottom quartile in 2016	95%	0.2276679	67%	0.4731602
Average number of assets purchased after 2012	2.601942	1.996761	1.834951	2.288492
Drinking water system type change (% in household)	26%	0.4419468	4%	0.1941462
Drinking water system type 2016 (% in household)	53%	0.5012833	27%	0.4470859
Drinking water system type 2012 (% in household)	27%	0.4470859	23%	0.4248156
Time to fetch drinking water	-0.4902	-3.8823529	1.13229	12.42506
Time to fetch drinking water 2016	1.372549	2.420709	9.411765	13.532032
Time to fetch drinking water 2012	0.883495	2.276482	5.529412	7.569749
Dietary diversity	7.446602	1.672899	7.106796	1.644436
Spending on food last month (% reporting GEL 250 or less)	0.637255	0.4831664	0.796117	0.4048535

5. The table below presents the mean and standard deviation for the matched sample used for analysis of the impact of the leasing component for each of the variables presented in the analysis in the main body of the report as well as its components (i.e. the 2012 and 2016 data).

Table 5
Leasing matched sample descriptive statistics

<i>Variable</i>	<i>Treatment group</i>		<i>Control group</i>	
	<i>Mean</i>	<i>Standard deviation</i>	<i>Mean</i>	<i>Standard deviation</i>
Household agricultural income (change)	4618.074	19584.861	445.0645	4534.998
Household agricultural income 2016	9966.568	19964.591	4191.306	5614.864
Household agricultural income 2012	6015.986	11465.041	3499.527	5284.385
Household non-agricultural income (change)	2493.276	7837.628	1520.738	4495.695
Household non-agricultural income 2016	6329.71	10072.387	5888.326	5510.428
Household non-agricultural income 2012	4078.887	5702.757	4545.314	5461.976
% above 2012 inflation adjusted bottom quartile in 2016	87%	0.3387378	82%	0.3871935
Average number of assets purchased after 2012	4.541333	2.615825	3.869333	2.521881
Dietary diversity	8.408	2.037467	8.472	2.240521
Spending on food last month (% reporting GEL 250 or less)	43%	0.4952049	46%	0.4988731

6. The table below presents the mean and standard deviation for the matched sample used for analysis of the impact on female headed households for each of the variables tested for impact as well as their components (i.e. the 2012 and 2016 data).

Table 6
Female headed household matched sample descriptive statistics

<i>Variable</i>	<i>Treatment group</i>		<i>Control group</i>	
	<i>Mean</i>	<i>Standard deviation</i>	<i>Mean</i>	<i>Standard deviation</i>
Household agricultural income (change)	-47.2222	1362.9124	26.46341	741.1242
Household agricultural income 2016	408.5185	1212.489	455.2632	1 008.171
Household agricultural income 2012	417.973	1538.4701	346.747	573.8937
Household non-agricultural Income (change)	753.3898	2 363.665	1 145.064	2 137.494
Household non-agricultural income 2016	3 279.433	3 293.84	3 308.231	2 686.262
Household Non-Agricultural Income 2012	2 660.258	3 632.79	2121.8	1856.961
Percentage above 2012 inflation adjusted bottom quartile in 2016	87%	0.3390495	84%	0.3734378
Average number of assets purchased after 2012	1.606061	1.80033	1.656566	1.922804
Dietary diversity	6.858586	2.276813	6.606061	1.88884
Spending on food last month (% reporting GEL 250 or less)	0.88172	0.3246892	0.886598	0.3187308

Match balance statistics

1. This section presents the balance between treatment and control groups for each group analysis that was carried out. In total, six different groups were analysed separately:
 - 1) Irrigation
 - 2) Drinking water
 - 3) Bridge
 - 4) Leasing
 - 5) Female headed households
 - 6) All surveyed households
2. Three tables are presented for each of the above groups. They correspond to:
 - 1) Balance before matching;
 - 2) Balance after matching using propensity score matching;
 - 3) Balance after matching using genetic matching.
3. In each table six statistics are presented including:
 - 1) Mean of treated group
 - 2) Mean of control group
 - 3) Mean standard difference
 - 4) Kolmogorov-Smirnov bootstrapped p-values
 - 5) T-test p-value
 - 6) Maximum empirical quintile difference
4. These statistics provide information about whether significant differences remain between treatment and control groups as well as the size of those differences. A seventh statistic presented for each group is the number of significant t-test p-values. This provides a general sense of the improvement gained from matching. In general, the overarching pattern is that while propensity score matching improves match balance, genetic matching provides even greater balance between treatment and control groups.

A. Irrigation

5. In irrigation communities, before matching, a total of seven significant t-test p-values were present prior to matching. Propensity score matching led to four significant differences on the variables matched on. Genetic matching resulted in zero significant differences after matching, without the use of calipers.

Table 1

Irrigation community balance between treatment and control groups before matching

Irrigation communities balance before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrapped p-val before matching	t-test p-val before matching	Max eQQ diff. before matching
Number of people in household	3.86	4.01	-7.71	0.0976	0.10212	2
Average age of household	44.934	44.454	2.9886	0.2944	0.52671	6
Average age of adults in household	49.968	50.205	-1.8842	0.601	0.69094	6

Variable	Irrigation communities balance before matching					
	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrapped p-val before matching	t-test p-val before matching	Max eQQ diff. before matching
Age of self-identified household head	55.019	55.29	-1.9587	0.1284	0.68787	6
Female self-identified most informed of household affairs	0.57524	0.55403	4.2889	NA	0.35391	1
Armenian	0.25607	0.24359	2.8572	NA	0.53295	1
Azerbaijani	0.0024272	0.12821	-255.46	NA	< 2.22E-16	1
Georgian	0.72816	0.60897	26.771	NA	3.0183E-08	1
Other Caucasian ethnicity	0.0084951	0.0045788	4.2647	NA	0.30242	1
Russian	0.0012136	0.010073	-25.432	NA	0.0066161	1
Other ethnicity	0.0024272	0.003663	-2.51	NA	0.62217	1
No formal education	0.0012136	0.003663	-7.0311	NA	0.26461	1
Primary education only	0.01699	0.033883	-13.063	NA	0.017322	1
Incomplete secondary education	0.075243	0.13462	-22.495	NA	0.000018557	1
Completed secondary education	0.45024	0.4185	6.3767	NA	0.16561	1
Secondary technical education	0.30825	0.25916	10.625	NA	0.018698	1
Incomplete higher education	0.0097087	0.0091575	0.90191	NA	0.90191	1
Completed higher education	0.13714	0.13828	-0.33192	NA	0.94275	1
Graduate education	0	0.00091575	-Inf	NA	0.31753	1
Armenian Apostolic Church	0.18083	0.17857	0.58524	NA	0.89887	1
Catholic	0.072816	0.077839	-1.9321	NA	0.67954	1
Georgian Orthodox	0.72694	0.55586	38.376	NA	4.4409E-15	1
Other Christian	0.0097087	0.0045788	5.2286	NA	0.19791	1

Irrigation communities balance before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrapped p-val before matching	t-test p-val before matching	Max eQQ diff. before matching
Muslim	0.0036408	0.17491	-284.19	NA	< 2.22e-16	1
Land owned in 2012	7341	7886	-6.6915	< 2.22e-16	0.2821	150000
Grew high value crops in 2012	0.49272	0.30037	38.451	NA	< 2.22e-16	1
Grew staple crops in 2012	0.32282	0.40385	-17.32	NA	0.00024522	1
Irrigated land in 2012	0.68083	0.37729	65.075	NA	< 2.22e-16	1
Amount of land irrigated in 2012	5903.9	5663	1.8634	< 2.22e-16	0.68712	40000

Table 2
Irrigation community balance between treatment and control groups after propensity score matching

Irrigation communities balance after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	3.8653	3.8699	-0.23635	0.175	0.96072	2
Average age of household	44.934	44.204	4.5455	0.35133	0.35161	6
Average age of adults in household	49.968	48.896	8.5295	0.0083333	0.089174	6
Age of self-identified household head	55.019	53.705	9.5052	0.054333	0.066708	6
Female self-identified most informed of household affairs	0.57524	0.54704	5.7023	NA	0.2249	1
Armenian	0.25607	0.32378	-15.505	NA	0.0019845	1
Azerbaijani	0.0024272	0.00086685	3.1691	NA	0.43521	1
Georgian	0.72816	0.6687	13.356	NA	0.0068558	1
Other Caucasian ethnicity	0.0084951	0.0033374	5.6165	NA	0.17337	1
Russian	0.0012136	0.00020227	2.9031	NA	0.44046	0
Other ethnicity	0.0024272	0.0028722	-0.90377	NA	0.86075	1
No formal	0.0012136	0	3.4837	NA	0.31731	1

Irrigation communities balance after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
education						
Primary education only	0.01699	0.022108	-3.9573	NA	0.45121	1
Incomplete secondary education	0.075243	0.051995	8.8078	NA	0.045743	1
Completed secondary education	0.45024	0.47621	-5.2166	NA	0.25873	1
Secondary technical education	0.30825	0.29036	3.8732	NA	0.40759	1
Incomplete higher education	0.13714	0.15089	-3.9972	NA	0.41653	1
Completed higher education	0.0097087	0.0078883	1.8554	NA	0.69372	1
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0.18083	0.1745	1.6432	NA	0.70688	1
Catholic	0.072816	0.13969	-25.721	NA	0.000011179	1
Georgian Orthodox	0.72694	0.66055	14.892	NA	0.0027198	1
Other Christian	0.0097087	0.014361	-4.7416	NA	0.36404	1
Muslim	0.0036408	0.0036408	0	NA	1	0
Land owned in 2012	7341	7550.8	-2.5751	0.00033333	0.60261	40000
Grew high value crops in 2012	0.68083	0.66398	3.611	NA	0.14491	1
Grew staple crops in 2012	0.32282	0.30656	3.4751	NA	0.39254	1
Irrigated land in 2012	0.49272	0.49388	-0.23162	NA	0.95549	1
Amount of land irrigated in 2012	5903.9	5883.9	0.15435	2.22E-16	0.96987	210000

Table 3
Irrigation community balance between treatment and control groups after genetic matching

Variable	Irrigation communities after genetic matching					
	Mean treated after matching	Mean control after matching	Mean std diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	3.8653	3.7718	4.7947	0.066	0.31072	3
Average age of household	44.934	44.372	3.4999	0.2824	0.46696	6
Average age of adults in household	49.968	49.445	4.1611	0.1456	0.38516	6
Age of self-identified household head	55.019	54.549	3.4049	0.2708	0.49152	4
Female self-identified most informed of household affairs	0.57524	0.57282	0.49073	NA	0.9207	1
Armenian	0.25607	0.25728	-0.27788	NA	0.95506	1
Azerbaijani	0.0024272	0.0024272	0	NA	1	0
Georgian	0.72816	0.72816	0	NA	1	0
Other Caucasian ethnicity	0.0084951	0.0084951	0	NA	1	0
Russian	0.0012136	0.0012136	0	NA	1	0
Other ethnicity	0.0024272	0.0024272	0	NA	1	0
No formal education	0.0012136	0.0012136	0	NA	1	0
Primary education only	0.01699	0.01699	0	NA	1	0
Incomplete secondary education	0.075243	0.075243	0	NA	1	0
Completed secondary education	0.45024	0.45388	-0.73134	NA	0.88205	1
Secondary technical education	0.30825	0.29733	2.3639	NA	0.62969	1
Incomplete higher education	0.0097087	0.0097087	0	NA	1	0
Completed higher education	0.13714	0.14563	-2.4681	NA	0.62092	1

Irrigation communities after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0.18083	0.18204	-0.31513	NA	0.94907	1
Catholic	0.072816	0.074029	-0.46678	NA	0.92481	1
Georgian Orthodox	0.72694	0.72573	0.27223	NA	0.95597	1
Other Christian	0.0097087	0.0097087	0	NA	1	0
Muslim	0.0036408	0.0036408	0	NA	1	0
Land owned in 2012	7341	6804.1	6.5929	0.0738	0.20638	70000
Grew high value crops in 2012	0.49272	0.50364	-2.1834	NA	0.65771	1
Grew staple crops in 2012	0.32282	0.34466	-4.6693	NA	0.34736	1
Irrigated land in 2012	0.68083	0.67718	0.78055	NA	0.87432	1
Amount of land irrigated in 2012	5903.9	5332.6	4.4199	0.0084	0.3007	100000

B. Drinking water community balance tables

6. In the drinking water communities, prior to matching, there were 23 significant t-test p-values. Both propensity score matching and genetic matching reduced this to zero significant differences. Although both strategies resulted in no significant differences on this statistic, genetic matching still led to a lower max empirical quantile differences as well as significant ks-test bootstrapped p-values, thus suggesting it again provided better match balance than propensity score matching.

Table 4
Drinking water community balance between treatment and control groups before matching

Variable	Drinking communities balance before matching					
	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Number of people in households	2.8447	4.0156	-74.566	2.22E-16	9.0966E-11	3
Average age of household	54.548	44.454	60.429	2.22E-16	4.0564E-08	15.3
Average age of adults in household	57.77	50.205	56.066	2.22E-16	2.7467E-07	12.25
Age of self-identified household head	59.883	55.29	31.437	0.023	0.0029547	10
Female self-identified most informed of household affairs	0.62136	0.55403	13.814	NA	0.18344	1
Armenian	0	0.24359	-Inf	NA	2.22E-16	1
Azerbaijani	0	0.12821	-Inf	NA	2.22E-16	1
Georgian	0.99029	0.60897	386.99	NA	2.22E-16	1
Other Caucasian ethnicity	0	0.0045788	-Inf	NA	0.02528	1
Russian	0	0.010073	-Inf	NA	0.00089138	1
Other ethnicity	0.0097087	0.003663	6.1358	NA	0.54184	0
No formal education	0.019417	0.003663	11.362	NA	0.25566	1
Primary education only	0	0.033883	-Inf	NA	8.7304E-10	1
Incomplete secondary education	0.058252	0.13462	-32.444	NA	0.0031009	1
Completed secondary education	0.24272	0.4185	-40.801	NA	0.00015071	1
Secondary technical education	0.47573	0.25916	43.154	NA	0.000046589	1
Incomplete higher education	0.0097087	0.0091575	0.55944	NA	0.95669	1
Completed higher education	0.19417	0.13828	14.062	NA	0.17056	1
Graduate education	0	0.00091575	-Inf	NA	0.31753	1
Armenian Apostolic Church	0	0.17857	-Inf	NA	2.22E-16	1

Drinking communities balance before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Catholic	0	0.077839	-Inf	NA	2.22E-16	1
Georgian Orthodox	1	0.55586	Inf	NA	2.22E-16	1
Other Christian	0	0.0045788	-Inf	NA	0.02528	1
Muslim	0	0.17491	-Inf	NA	2.22E-16	1
Land owned in 2012	2659	7886	-94.922	2.22E-16	5.1181E-13	230000
Grew high value crops in 2012	0.83495	0.30037	143.31	NA	2.22E-16	1
Grew staple crops in 2012	0.66019	0.40385	53.859	NA	7.6459E-07	1
Irrigated land in 2012	0.067961	0.37729	-122.31	NA	2.22E-16	1
Amount of land irrigated in 2012	1303.9	5663	-193.96	2.22E-16	2.22E-16	265000

Table 5
Drinking water community balance between treatment and control groups after propensity score matching

Drinking communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	2.8447	2.681	10.423	2.22E-16	0.46477	5
Average age of household	54.548	55.939	-8.3246	2.22E-16	0.54255	30
Average age of adults in household	57.77	58.514	-5.5137	2.22E-16	0.68215	22.75
Age of self-identified household head	59.883	60.114	-1.576	2.22E-16	0.90949	48
Female self-identified most informed of household affairs	0.62136	0.71317	-18.836	NA	0.1486	1
Armenian	0	0.0044835	-Inf	NA	0.49736	1
Azerbaijani	0	0.0023598	-Inf	NA	0.62266	1
Georgian	0.99029	0.99284	-2.5831	NA	0.84274	1
Other Caucasian ethnicity	0	0.000084277	-Inf	NA	0.92595	1

Drinking communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Russian	0	0.00018541	-Inf	NA	0.89035	1
Other ethnicity	0.0097087	0.000033711	9.8191	NA	0.31986	1
No formal education	0.019417	0.048594	-21.042	NA	0.25587	1
Primary education only	0	0.00062365	-Inf	NA	0.80037	1
Incomplete secondary education	0.058252	0.07558	-7.3619	NA	0.63138	1
Completed secondary education	0.24272	0.1902	12.191	NA	0.3692	1
Secondary technical education	0.47573	0.52316	-9.4512	NA	0.47252	1
Incomplete higher education	0.19417	0.14231	13.048	NA	0.32921	1
Completed higher education	0.0097087	0.019485	-9.9217	NA	0.56209	1
Graduate education	0	0.000016855	-Inf	NA	0.96685	1
Armenian Apostolic Church	0	0.0032868	-Inf	NA	0.56131	1
Catholic	0	0.0014327	-Inf	NA	0.70147	1
Georgian Orthodox	1	0.99183	Inf	NA	0.35902	1
Other Christian	0	0.000084277	-Inf	NA	0.92595	1
Muslim	0	0.0032194	-Inf	NA	0.56536	1
Land owned in 2012	2659	3283.9	-11.348	2.22E-16	0.28131	230000
Grew high value crops in 2012	0.83495	0.86709	-8.6166	NA	0.41338	1
Grew staple crops in 2012	0.66019	0.68263	-4.7136	NA	0.68633	1
Irrigated land in 2012	0.067961	0.073085	-2.026	NA	0.85691	1
Amount of land irrigated in 2012	1303.9	1632.1	-14.604	2.22E-16	0.29606	265000

Table 6
Drinking water community balance between treatment and control groups after genetic matching

Variable	Drinking communities after genetic matching					
	Mean treated after matching	Mean control after matching	Mean std diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	2.8447	2.6408	12.984	0.1408	0.35831	1
Average age of household	54.548	55.442	-5.3518	0.2498	0.69737	5.8333
Average age of adults in household	57.77	58.244	-3.519	0.2398	0.79425	4
Age of self-identified household head	59.883	59.903	-0.1329	0.5916	0.9924	8
Female self-identified most informed of household affairs	0.62136	0.73786	-23.902	NA	0.073814	1
Armenian	0	0	0	NA	1	0
Azerbaijani	0	0	0	NA	1	0
Georgian	0.99029	0.99029	0	NA	1	0
Other Caucasian ethnicity	0	0	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0.0097087	0.0097087	0	NA	1	0
No formal education	0.019417	0.019417	0	NA	1	0
Primary education only	0	0	0	NA	1	0
Incomplete secondary education	0.058252	0.058252	0	NA	1	0
Completed secondary education	0.24272	0.25243	-2.2535	NA	0.87252	1
Secondary technical education	0.47573	0.46602	1.9346	NA	0.88966	1
Incomplete higher education	0.0097087	0.0097087	0	NA	1	0
Completed higher education	0.19417	0.19417	0	NA	1	0
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0	0	0	NA	1	0

Drinking communities after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Catholic	0	0	0	NA	1	0
Georgian Orthodox	1	1	0	NA	1	0
Other Christian	0	0	0	NA	1	0
Muslim	0	0	0	NA	1	0
Land owned in 2012	2659	3157.5	-9.0518	0.0018	0.47222	15000
Grew high value crops in 2012	0.83495	0.83495	0	NA	1	0
Grew staple crops in 2012	0.66019	0.63107	6.1195	NA	0.66398	1
Irrigated land in 2012	0.067961	0.048544	7.6776	NA	0.55415	1
Amount of land irrigated in 2012	1303.9	1575.9	-12.104	0.0052	0.43333	5000

C. Bridge community match balance tables

7. In the bridge communities, a total of 26 t-test p-values were present prior to matching. Propensity score matching led to nine significant differences on the variables matched on. Genetic matching resulted in two significant differences after matching, with the use of calipers; smaller calipers were not appropriate to use given the issues which would result with statistical power.

Table 7

Bridge community balance between treatment and control groups before matching

Bridge communities before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Number of people in household	4.5	4.0156	23.001	0.038667	0.022727	1
Average age of household	37.716	44.454	-46.025	0.00033333	0.000012388	13
Average age of adults in household	45.298	50.205	-42.956	0.00066667	0.000042819	12
Age of self-identified household head	48.427	55.29	-44.475	2.22E-16	0.000018631	11
Female self-identified most informed of household affairs	0.37273	0.55403	-37.325	NA	0.00028958	1
Armenian	0	0.24359	-Inf	NA	2.22E-16	1
Azerbaijani	1	0.12821	Inf	NA	2.22E-16	1
Georgian	0	0.60897	-Inf	NA	2.22E-16	1

Bridge communities before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Other Caucasian ethnicity	0	0.0045788	-Inf	NA	0.02528	1
Russian	0	0.010073	-Inf	NA	0.00089138	1
Other ethnicity	0	0.003663	-Inf	NA	0.045451	1
No formal education	0.072727	0.003663	26.474	NA	0.0065966	1
Primary education only	0.13636	0.033883	29.727	NA	0.0026267	1
Incomplete secondary education	0.40909	0.13462	55.571	NA	9.061E-08	1
Completed secondary education	0.24545	0.4185	-40.026	NA	0.0001251	1
Secondary technical education	0.090909	0.25916	-58.259	NA	1.3946E-07	1
Incomplete higher education	0	0.0091575	-Inf	NA	0.0015382	1
Completed higher education	0.036364	0.13828	-54.196	NA	1.9249E-06	1
Graduate education	0.0090909	0.00091575	8.5742	NA	0.37286	0
Armenian Apostolic Church	0	0.17857	-Inf	NA	2.22E-16	1
Catholic	0	0.077839	-Inf	NA	2.22E-16	1
Georgian Orthodox	0	0.55586	-Inf	NA	2.22E-16	1
Other Christian	0	0.0045788	-Inf	NA	0.02528	1
Muslim	1	0.17491	Inf	NA	2.22E-16	1
Land owned in 2012	4956.1	7886	-45.124	2.22E-16	0.00011832	240000
Grew high value crops in 2012	0.054545	0.30037	-107.75	NA	2.22E-16	1
Grew staple crops in 2012	0.22727	0.40385	-41.943	NA	0.000063016	1
Irrigated land in 2012	0.44545	0.37729	13.652	NA	0.17356	1
Amount of land irrigated in 2012	3066.3	5663	-48.052	2.22E-16	0.00008036	255000

Table 8
Bridge community balance between treatment and control groups after propensity score matching

Bridge communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in household	4.5	4.0545	21.15	2.22E-16	0.11349	2
Average age of household	37.716	32.934	32.672	2.22E-16	0.0030889	15.5
Average age of adults in household	45.298	41.002	37.608	2.22E-16	0.0006359	11.667
Age of self-identified household head	48.427	44.073	28.219	0.00033333	0.011482	16
Female self-identified most informed of household affairs	0.37273	0.48182	-22.459	NA	0.088322	1
Armenian	0	0	0	NA	1	0
Azerbaijani	0	0	0	NA	1	0
Georgian	0	0	0	NA	1	0
Other Caucasian ethnicity	0	0	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0	0	0	NA	1	0
No formal education	0.072727	0	27.878	NA	0.0040411	1
Primary education only	0.13636	0	39.555	NA	0.000061913	1
Incomplete secondary education	0.40909	0.41364	-0.92029	NA	0.93507	1
Completed secondary education	0.24545	0.45455	-48.364	NA	0.0022832	1
Secondary technical education	0.090909	0.10455	-4.7218	NA	0.72045	1
Incomplete higher education	0.036364	0.027273	4.8343	NA	0.70601	1
Completed higher education	0	0	0	NA	1	0
Graduate education	0.0090909	0	9.5346	NA	0.31733	1
Armenian Apostolic Church	0	0	0	NA	1	0
Catholic	0	0	0	NA	1	0
Georgian Orthodox	0	0	0	NA	1	0
Other Christian	0	0	0	NA	1	0
Muslim	1	1	0	NA	1	0
Land owned in 2012	4956.1	7890	-45.185	0.0013333	0.001063	20000
Grew high value crops in 2012	0.054545	0	23.91	NA	0.013214	1

Bridge communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Grew staple crops in 2012	0.22727	0.14545	19.435	NA	0.081869	1
Irrigated land in 2012	0.44545	0.50455	-11.835	NA	0.36528	1
Amount of land irrigated in 2012	3066.3	1383.6	31.138	2.22E-16	0.0034652	1

Table 9
Bridge community balance between treatment and control groups after genetic matching

Bridge communities after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in household	4.7209	4.9419	-10.628	0.539	0.5199	3
Average age of household	36.58	33.178	24.063	0.0144	0.019101	0.10339
Average age of adults in household	44.516	42.383	19.779	0.0368	0.16227	12
Age of self-identified household head	47.488	45.756	12.052	0.2012	0.42414	10
Female self-identified most informed of household affairs	0.31395	0.23256	17.436	NA	0.23348	1
Armenian	0	0	0	NA	1	0
Azerbaijani	1	1	0	NA	1	0
Georgian	0	0	0	NA	1	0
Other Caucasian ethnicity	0	0	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0	0	0	NA	1	0
No formal education	0	0	0	NA	1	0
Primary education only	0	0	0	NA	1	0
Incomplete secondary education	0.52326	0.52326	0	NA	1	0
Completed secondary education	0.31395	0.32558	-2.4909	NA	0.87107	1
Secondary technical education	0.11628	0.10465	3.6062	NA	0.80918	1

Bridge communities after genetic matching						
<i>Variable</i>	<i>Mean treated after matching</i>	<i>Mean control after matching</i>	<i>Mean std. diff. after matching</i>	<i>ks-test bootstrap p-val after matching</i>	<i>t-test p-val after matching</i>	<i>Max eQQ diff after matching</i>
Incomplete higher education	0	0	0	NA	1	0
Completed higher education	0.046512	0.046512	0	NA	1	0
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0	0	0	NA	1	0
Catholic	0	0	0	NA	1	0
Georgian Orthodox	0	0	0	NA	1	0
Other Christian	0	0	0	NA	1	0
Muslim	1	1	0	NA	1	0
Land owned in 2012	5403.1	4026.7	20.489	0.0106	0.14112	20000
Grew high value crops in 2012	0.034884	0	18.901	NA	0.083243	1
Grew staple crops in 2012	0.22093	0.19767	5.5728	NA	0.70974	1
Irrigated land in 2012	0.45349	0.47674	-4.6442	NA	0.76147	1
Amount of land irrigated in 2012	3237.2	1815	25.449	2.22E-16	0.034789	15000

D. Leasing match balance tables

8. In the leasing component sample, a total of 26 t-test p-values were present prior to matching. Propensity score matching led to nine significant differences on the variables matched on. Genetic matching resulted in two significant differences after matching, with the use of calipers; smaller calipers were not appropriate to use given the issues which would result with statistical power.

Table 10
Leasing sample balance between treatment and control groups before matching

Variable	Leasing component before matching					
	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Number of people in households	3.712	3.8688	-8.5399	0.054667	0.18555	1
Average age of household	47.471	46.673	5.5346	0.097333	0.40248	5.5
Average age of adults in household	51.778	51.533	2.1704	0.11467	0.74339	5.5
Age of self-identified household head	54.555	55.401	-6.131	0.105	0.35023	7
Female self-identified most informed of household affairs	0.38667	0.54519	-32.508	NA	6.3114E-07	1
Armenian	0.010667	0.0029155	7.5354	NA	0.1743	1
Azerbaijani	0	0.0014577	-Inf	NA	0.31766	0
Georgian	0.97333	0.98688	-8.3975	NA	0.14994	1
Other Caucasian ethnicity	0.013333	0.0058309	6.5323	NA	0.25656	1
Russian	0	0.0014577	-Inf	NA	0.31766	1
Other ethnicity	0.0026667	0.0014577	2.3411	NA	0.69092	0
No formal education	0.0026667	0.0014577	2.3411	NA	0.69092	0
Primary education only	0.0026667	0.0072886	-8.9504	NA	0.27184	1
Incomplete secondary education	0.024	0.039359	-10.022	NA	0.15743	1
Completed secondary education	0.25867	0.33965	-18.469	NA	0.0053282	1
Secondary technical education	0.312	0.34694	-7.5311	NA	0.24575	1
Incomplete higher education	0.37867	0.25656	25.14	NA	0.000056137	1
Completed higher education	0.018667	0.0087464	7.3199	NA	0.20689	1
Graduate education	0.0026667	0	5.164	NA	0.31796	1

Leasing component before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Armenian Apostolic Church	0	0.0014577	-Inf	NA	0.31766	1
Catholic	0.008	0	8.9683	NA	0.083263	1
Georgian Orthodox	0.98933	0.99125	-1.8668	NA	0.76398	1
Other Christian	0	0.0043732	-Inf	NA	0.083264	1
Muslim	0	0	0	NA	1	0
Land owned in 2012	32077	17193	20.884	2.22E-16	0.000099129	480000
Grew high value crops in 2012	0.74667	0.7172	6.7659	NA	0.2984	1
Grew staple crops in 2012	0.384	0.3309	10.903	NA	0.086296	1
Irrigated land in 2012	0.24	0.22595	3.2859	NA	0.60634	1
Amount of land irrigated in 2012	30309	14250	21.753	2.22E-16	0.000043787	480000

Table 11
Leasing sample balance between treatment and control groups after propensity score matching

Leasing component indirect beneficiary after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in household	3.712	3.7697	-3.1426	0.637	0.667	2
Average age of household	47.471	47.099	2.5756	0.392	0.72207	5
Average age of adults in household	51.778	51.075	6.2209	0.066333	0.40422	4.5
Age of self-identified household head	54.555	52.163	17.328	0.012667	0.020734	5
Female self-identified most informed of household affairs	0.38667	0.36346	4.7589	NA	0.4087	1
Armenian	0.010667	0.0026667	7.7772	NA	0.082854	1
Azerbaijani	0	0	0	NA	1	0
Georgian	0.97333	0.99444	-13.086	NA	0.012355	1

Leasing component indirect beneficiary after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Other Caucasian ethnicity	0.013333	0.0022222	9.6744	NA	0.084089	1
Russian	0	0	0	NA	1	0
Other ethnicity	0.0026667	0.00066667	3.873	NA	0.50249	0
No formal education	0.0026667	0.0026667	0	NA	1	0
Primary education only	0.0026667	0	5.164	NA	0.31731	1
Incomplete secondary education	0.024	0.015714	5.4065	NA	0.38693	1
Completed secondary education	0.25867	0.28239	-5.4104	NA	0.42726	1
Secondary technical education	0.312	0.2921	4.2898	NA	0.53435	1
Incomplete higher education	0.37867	0.3818	-0.64446	NA	0.91733	1
Completed higher education	0.018667	0.025333	-4.9191	NA	0.53842	1
Graduate education	0.0026667	0	5.164	NA	0.31731	1
Armenian Apostolic Church	0	0	0	NA	1	0
Catholic	0.008	0	8.9683	NA	0.082854	1
Georgian Orthodox	0.98933	1	-10.37	NA	0.045069	1
Other Christian	0	0	0	NA	1	0
Muslim	0	0	0	NA	1	0
Land owned in 2012	32077	33752	-2.3499	2.22E-16	0.56233	480000
Grew high value crops in 2012	0.74667	0.72744	4.4145	NA	0.54536	1
Grew staple crops in 2012	0.384	0.37332	2.1935	NA	0.754	1
Irrigated land in 2012	0.24	0.23292	1.6561	NA	0.81947	1
Amount of land irrigated in 2012	30309	30779	-0.6367	2.22E-16	0.86154	480000

Table 12
Leasing sample balance between treatment and control groups after genetic matching

Variable	Leasing component indirect beneficiary after genetic matching					Max eQQ diff after matching
	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	
Number of people in household	3.712	3.8347	-6.6807	0.1138	0.12653	3
Average age of household	47.471	46.968	3.4839	0.4416	0.19045	6
Average age of adults in household	51.778	51.367	3.6413	0.4204	0.20223	6
Age of self-identified household head	54.555	53.203	9.7956	0.007	0.0019731	7
Female self-identified most informed of household affairs	0.38667	0.37867	1.6406	NA	0.25675	1
Armenian	0.010667	0.010667	0	NA	1	0
Azerbaijani	0	0	0	NA	1	0
Georgian	0.97333	0.97333	0	NA	1	0
Other Caucasian ethnicity	0.013333	0.013333	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0.0026667	0.0026667	0	NA	1	0
No formal education	0.0026667	0.0026667	0	NA	1	0
Primary education only	0.0026667	0	5.164	NA	0.31731	1
Incomplete secondary education	0.024	0.021333	1.74	NA	0.31731	1
Completed secondary education	0.25867	0.25867	0	NA	1	0
Secondary technical education	0.312	0.31733	-1.1496	NA	0.52726	1
Incomplete higher education	0.37867	0.38133	-0.54903	NA	0.78164	1
Completed higher education	0.018667	0.018667	0	NA	1	0
Graduate education	0.0026667	0	5.164	NA	0.31731	1
Armenian Apostolic Church	0	0	0	NA	1	0

Leasing component indirect beneficiary after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Catholic	0.008	0	8.9683	NA	0.082854	1
Georgian Orthodox	0.98933	0.99467	-5.1848	NA	0.15702	1
Other Christian	0	0	0	NA	1	0
Muslim	0	0	0	NA	1	0
Land owned in 2012	32077	26251	8.1754	0.0248	0.0050394	480000
Grew high value crops in 2012	0.74667	0.77067	-5.5109	NA	0.028646	1
Grew staple crops in 2012	0.384	0.4	-3.2854	NA	0.057346	1
Irrigated land in 2012	0.24	0.208	7.4827	NA	0.010231	1
Amount of land irrigated in 2012	30309	24480	7.8953	0.0896	0.0020407	480000

E. Female headed household sample match balance tables

9. In female headed households, a total of 2 t-test p-values were present prior to matching. Propensity score matching and genetic matching resulted in no significant differences.

Table 13

Female headed household sample balance between treatment and control groups before matching

Female headed households before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. after matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Number of people in households	1.4242	1.3904	4.3172	0.89167	0.73449	1
Average age of household	64.369	64.017	2.7274	0.91633	0.84418	9.7333
Average age of adults in household	65.197	64.679	4.5923	0.88933	0.74562	9.5
Age of self-identified household head	66.03	65.11	8.0135	0.385	0.55658	8
Female self-identified most informed of household affairs	1	1	0	NA	1	0
Armenian	0.090909	0.12329	-11.206	NA	0.41745	1
Azerbaijani	0.090909	0.12329	-11.206	NA	0.41745	1
Georgian	0.80808	0.71918	22.461	NA	0.10452	1

Female headed households before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. after matching	ks-test bootstrap p-val before matching	t-test p-val before matching	Max eQQ diff before matching
Other Caucasian ethnicity	0.010101	0.013699	-3.5796	NA	0.79703	0
Russian	0	0.013699	-Inf	NA	0.15801	1
Other ethnicity	0	0.0068493	-Inf	NA	0.31898	1
No formal education	0.030303	0.013699	9.6373	NA	0.40354	1
Primary education only	0.020202	0.027397	-5.0883	NA	0.71444	1
Incomplete secondary education	0.10101	0.15068	-16.401	NA	0.24406	1
Completed secondary education	0.35354	0.32877	5.1547	NA	0.69033	1
Secondary technical education	0.31313	0.30137	2.5232	NA	0.84577	1
Incomplete higher education	0.16162	0.17123	-2.5993	NA	0.84331	1
Completed higher education	0.020202	0	14.286	NA	0.15835	1
Graduate education	0	0.0068493	-Inf	NA	0.31898	1
Armenian Apostolic Church	0.070707	0.09589	-9.7746	NA	0.48022	1
Catholic	0.020202	0.034247	-9.932	NA	0.49892	1
Georgian Orthodox	0.81818	0.73288	22.005	NA	0.11258	1
Other Christian	0	0	0	NA	1	0
Muslim	0.090909	0.12329	-11.206	NA	0.41745	1
Land owned in 2012	4892.3	5499.1	-10.372	0.33567	0.43964	5000
Grew high value crops in 2012	0.53535	0.32192	42.578	NA	0.00094412	1
Grew staple crops in 2012	0.28283	0.27397	1.9563	NA	0.88016	1
Irrigated land in 2012	0.55556	0.19863	71.466	NA	1.4929E-08	1
Amount of land irrigated in 2012	2746.4	3168.5	-10.196	0.207	0.49445	15000

Table 14
Female headed household sample balance between treatment and control groups after propensity score matching

Female headed households after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Std. mean diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	1.4242	1.5303	-13.534	0.405	0.32653	1
Average age of household	64.369	64.369	0.0026118	0.243	0.99985	6.6667
Average age of adults in household	65.197	65.018	1.5903	0.187	0.9146	6
Age of self-identified household head	66.03	63.995	17.715	0.0086667	0.26898	16
Female self-identified most informed of household affairs	1	1	0	NA	1	0
Armenian	0.090909	0.10101	-3.4959	NA	0.78201	1
Azerbaijani	0.090909	0.15657	-22.723	NA	0.15003	1
Georgian	0.80808	0.72222	21.692	NA	0.12249	1
Other Caucasian ethnicity	0.010101	0.020202	-10.05	NA	0.56437	1
Russian	0	0	0	NA	1	0
Other ethnicity	0	0	0	NA	1	0
No formal education	0.030303	0.010101	11.725	NA	0.15626	1
Primary education only	0.020202	0	14.286	NA	0.15626	1
Incomplete secondary education	0.10101	0.11616	-5.0026	NA	0.73467	1
Completed secondary education	0.35354	0.36364	-2.1022	NA	0.88046	1
Secondary technical education	0.31313	0.24747	14.086	NA	0.31876	1
Incomplete higher education	0.16162	0.26263	-27.302	NA	0.089461	1
Completed higher education	0.020202	0	14.286	NA	0.15626	1
Graduate education	0	0	0	NA	1	0

Female headed households after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Std. mean diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Armenian Apostolic Church	0.070707	0.080808	-3.9206	NA	0.76356	1
Catholic	0.020202	0.030303	-7.1432	NA	0.56437	1
Georgian Orthodox	0.81818	0.73232	22.148	NA	0.09724	1
Other Christian	0	0	0	NA	1	0
Muslim	0.090909	0.15657	-22.723	NA	0.15003	1
Land owned in 2012	4892.3	4991.4	-1.6941	0.394	0.89448	10000
Grew high value crops in 2012	0.53535	0.57071	-7.0526	NA	0.40316	1
Grew staple crops in 2012	0.28283	0.19697	18.967	NA	0.12866	1
Irrigated land in 2012	0.55556	0.55556	0	NA	1	0
Amount of land irrigated in 2012	2746	2372.9	9.0202	0.16433	0.54026	15000

Table 15
Female headed household sample balance between treatment and control groups after genetic matching

Female headed households after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in household	1.4242	1.3737	6.4449	0.9626	0.27502	1
Average age of household	64.369	63.355	7.8601	0.8234	0.36709	5.6667
Average age of adults in household	65.197	63.869	11.782	0.8182	0.20334	8
Age of self-identified household head	66.03	65.343	5.9782	0.6778	0.49073	16
Female self-identified most informed of household affairs	1	1	0	NA	1	0
Armenian	0.090909	0.10101	-3.4959	NA	0.56437	1
Azerbaijani	0.090909	0.080808	3.4959	NA	0.31733	1
Georgian	0.80808	0.80808	0	NA	1	0

Female headed households after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Other Caucasian ethnicity	0.010101	0.010101	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0	0	0	NA	1	0
No formal education	0.030303	0.020202	5.8627	NA	0.31733	1
Primary education only	0.020202	0	14.286	NA	0.15626	1
Incomplete secondary education	0.10101	0.10101	0	NA	1	0
Completed secondary education	0.35354	0.38384	-6.3066	NA	0.31733	1
Secondary technical education	0.31313	0.31313	0	NA	1	0
Incomplete higher education	0.16162	0.18182	-5.4604	NA	0.31733	1
Completed higher education	0.020202	0	14.286	NA	0.15626	1
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0.070707	0.090909	-7.8412	NA	0.15626	1
Catholic	0.020202	0.020202	0	NA	1	0
Georgian Orthodox	0.81818	0.80808	2.6057	NA	0.31733	1
Other Christian	0	0	0	NA	1	0
Muslim	0.090909	0.080808	3.4959	NA	0.31733	1
Land owned in 2012	4892.3	4336.9	9.4939	0.584	0.23387	20000
Grew high value crops in 2012	0.53535	0.56566	-6.045	NA	0.25651	1
Grew staple crops in 2012	0.28283	0.21212	15.62	NA	0.24945	1
Irrigated land in 2012	0.55556	0.53535	4.045	NA	0.31733	1
Amount of land irrigated in 2012	2746.4	2315.1	10.417	0.3512	0.18131	12000

F. Entire sample match balance tables

10. In the entire, a total of 10 t-test p-values were present prior to matching. Propensity score matching and genetic matching resulted in two significant differences.

Table 16

All communities sample balance between treatment and control groups before matching

Variable	All communities before matching					
	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	max eQQ diff before matching
Number of people in households	3.7996	3.9589	-8.2414	0.017333	0.022078	2
Average age of household	45.747	45.31	2.7392	0.19133	0.44847	5
Average age of adults in household	50.654	50.717	-0.50676	0.66333	0.88886	5
Age of self-identified household head	54.737	55.333	-4.2022	0.25391	0.028667	5
Female self-identified most informed of household affairs	0.51275	0.55062	-7.5739	NA	0.033305	1
Armenian	0.15227	0.15073	0.42713	NA	0.90445	1
Azerbaijani	0.07932	0.079303	0.0064832	NA	0.99855	0
Georgian	0.75567	0.75478	0.2059	NA	0.95396	1
Other Caucasian ethnicity	0.0084986	0.0050619	3.7426	NA	0.24692	1
Russian	0.00070822	0.0067492	-22.7	NA	0.0035123	1
Other ethnicity	0.0028329	0.0028121	0.038957	NA	0.99127	0
No formal education	0.0084986	0.0028121	6.1925	NA	0.038618	1
Primary education only	0.021246	0.023622	-1.6468	NA	0.65186	1
Incomplete secondary education	0.086402	0.097863	-4.0776	NA	0.26489	1
Completed secondary education	0.36827	0.38808	-4.1045	NA	0.25178	1
Secondary technical education	0.30453	0.29303	2.4994	NA	0.4811	1
Incomplete higher education	0.19759	0.18391	3.4338	NA	0.32968	1
Completed higher education	0.011331	0.0089989	2.203	NA	0.51705	1
Graduate education	0.0014164	0.00056243	2.2699	NA	0.45716	1

All communities before matching						
Variable	Mean treated before matching	Mean control before matching	Mean std. diff. before matching	ks-test bootstrap p-val before matching	t-test p-val before matching	max eQQ diff before matching
Armenian Apostolic Church	0.10552	0.11024	-1.5332	NA	0.6698	1
Catholic	0.044618	0.047807	-1.544	NA	0.66955	1
Georgian Orthodox	0.75992	0.72385	8.4412	NA	0.020431	1
Other Christian	0.0056657	0.0044994	1.5533	NA	0.64771	1
Muslim	0.080028	0.10742	-10.093	NA	0.0078724	1
Land owned in 2012	13383	11477	4.8914	0.0086667	0.091119	480000
Grew high value crops in 2012	0.55099	0.46119	18.048	NA	4.4845E-07	1
Grew staple crops in 2012	0.35623	0.3757	-4.0644	NA	0.25665	1
Irrigated land in 2012	0.50071	0.3189	36.349	NA	2.22E-16	1
Amount of land irrigated in 2012	11829	8976.1	6.9809	0.40333	0.013685	480000

Table 17

All communities sample balance between treatment and control groups after propensity score matching

All communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	3.7996	3.8501	-2.6109	0.0066667	0.46411	2
Average age of household	45.747	45.463	1.781	0.032645	0.62991	5
Average age of adults in household	50.654	50.416	1.9094	0.18633	0.60926	5
Age of self-identified household head	54.737	54.216	3.674	0.00033333	0.33774	7
Female self-identified most informed of household affairs	0.51275	0.49752	3.0448	NA	0.39984	1
Armenian	0.15227	0.15255	-0.079133	NA	0.98301	1
Azerbaijani	0.07932	0.1013	-8.1314	NA	0.038379	1
Georgian	0.75567	0.73809	4.0895	NA	0.27632	1
Other Caucasian ethnicity	0.0084986	0.0058091	2.9289	NA	0.38617	0
Russian	0.00070822	0.00035411	1.3306	NA	0.68314	0
Other ethnicity	0.0028329	0.0018967	1.7607	NA	0.60906	1

All communities after propensity score matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
No formal education	0.0084986	0.0056893	3.0593	NA	0.37551	1
Primary education only	0.021246	0.023418	-1.5056	NA	0.69809	1
Incomplete secondary education	0.086402	0.092809	-2.2794	NA	0.54134	1
Completed secondary education	0.36827	0.37532	-1.461	NA	0.69107	1
Secondary technical education	0.30453	0.30494	-0.087845	NA	0.98081	1
Incomplete higher education	0.011331	0.0082086	2.9494	NA	0.39908	1
Completed higher education	0.19759	0.18704	2.6499	NA	0.47168	1
Graduate education	0.0014164	0.0021246	-1.8824	NA	0.65477	0
Armenian Apostolic Church	0.10552	0.10206	1.1268	NA	0.75439	1
Catholic	0.044618	0.043986	0.30584	NA	0.93565	1
Georgian Orthodox	0.75992	0.74859	2.6512	NA	0.48037	1
Other Christian	0.0056657	0.0029259	3.649	NA	0.25866	1
Muslim	0.080028	0.098115	-6.6635	NA	0.086716	1
Land owned in 2012	13383	13684	-0.77216	2.22E-16	0.78752	480000
Grew high value crops in 2012	0.55099	0.56343	-2.4993	NA	0.4487	1
Grew staple crops in 2012	0.35623	0.37043	-2.9627	NA	0.43181	1
Irrigated land in 2012	0.50071	0.48336	3.4684	NA	0.043679	1
Amount of land irrigated in 2012	11829	11811	0.044548	2.22E-16	0.98735	480000

Table 18
All communities sample balance between treatment and control groups after genetic matching

All communities after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Number of people in households	3.6183	3.5716	2.6394	0.5784	0.043912	1
Average age of household	46.564	46.243	2.0388	0.686	0.079282	5.5
Average age of adults in household	50.992	50.535	3.7258	0.0852	0.0064699	5.5
Age of self-identified household head	55.234	55.272	-0.29622	0.4928	0.83514	6
Female self-identified most informed of household affairs	0.54315	0.54315	0	NA	1	0
Armenian	0.11574	0.11574	0	NA	1	0
Azerbaijani	0.04467	0.04467	0	NA	1	0
Georgian	0.83959	0.83959	0	NA	1	0
Other Caucasian ethnicity	0	0	0	NA	1	0
Russian	0	0	0	NA	1	0
Other ethnicity	0	0	0	NA	1	0
No formal education	0.0020305	0.0020305	0	NA	1	0
Primary education only	0.0071066	0.0071066	0	NA	1	0
Incomplete secondary education	0.052792	0.052792	0	NA	1	0
Completed secondary education	0.39188	0.39188	0	NA	1	0
Secondary technical education	0.35533	0.35533	0	NA	1	0
Incomplete higher education	0.18782	0.18782	0	NA	1	0
Completed higher education	0.0030457	0.0030457	0	NA	1	0
Graduate education	0	0	0	NA	1	0
Armenian Apostolic Church	0.092386	0.092386	0	NA	1	0
Catholic	0.02335	0.02335	0	NA	1	0
Georgian Orthodox	0.83959	0.83959	0	NA	1	0
Other Christian	0	0	0	NA	1	0

All communities after genetic matching						
Variable	Mean treated after matching	Mean control after matching	Mean std. diff. after matching	ks-test bootstrap p-val after matching	t-test p-val after matching	Max eQQ diff after matching
Muslim	0.04467	0.04467	0	NA	1	0
Land owned in 2012	9323.5	9154.8	1.7022	2.22E-16	0.45606	10000
Grew high value crops in 2012	0.48528	0.48528	0	NA	1	0
Grew staple crops in 2012	0.61523	0.61523	0	NA	1	0
Irrigated land in 2012	0.3533	0.3533	0	NA	1	0
Amount of land irrigated in 2012	7362.5	7421	-0.62667	4.00E-04	0.79753	13100

Estimates of effects

In this annex, estimates are presented for project impact. An estimate is presented for the matched sample generated through propensity score matching and the matched sample that was generated through genetic matching. For continuous (or continuous-like) variables, ordinary least squares estimators are presented. For ordinal and binomial variables log odds are presented (inside the main body of the text, the exponentiated log odds are presented in order to ease interpretation).

Table 1
Overall project effects

<i>Variable</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	663.25(310.12)*
Household non-agricultural income (GEL)	330.56 (279.82)
Moving about baseline bottom quartile	0.19332 (0.25227)
Principal component of physical asset wealth	-0.065451 (0.079759)
Dietary diversity	0.020813 (0.229557)
Money on food	0.313 (0.1881).
Irrigated land	1025.33 (379.47)**
Cultivated land	71298.40 (70652.55)
Food crop land	303.93 (481.34)
High value added crop land	875.09 (676.35)

Table 2
Irrigation community effects

<i>Variable</i>	<i>Propensity score estimate</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	106.20 (155.60)	135.69 (172.08)
Household non-agricultural income (GEL)	248.80 (316.02)	81.51 (298.01)
Moving about baseline bottom quartile	0.031527 (0.370333)	-0.30024 (0.36856)
Principal component of physical asset wealth	-0.161346 (0.126383)	-0.106321 (0.132962)
Dietary diversity	0.048114 (0.318640)	0.18083 (0.35659)
Food spending	0.1860 (1.0421)	0.3038 (0.2423)
Irrigated land	1309.06 (919.19)	1494.75 (606.62)*
Cultivated land	155.73 (1212.43)	1253.06 (827.08)
Food crop land	1100.34 (514.25)*	883.51 (654.12)
High value added crop land	2517.0 (2240.9)	669.20955 (757.38493)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

Table 3
Bridge community effects

<i>Variable</i>	<i>Propensity score estimate</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	-178.32 (447.29)	-547.67 (496.06)
Household non-agricultural income (GEL)	332.34 (1195.12)	15.675 (1329.203)
Moving about baseline bottom quartile	1.0213 (1.3815)	1.90954 (0.77980)
Principal component of physical asset wealth	0.48122 (0.23241)*	-0.24953 (0.11334)
Cows	-0.012739 (0.234547)	-0.34218 (0.38466)
Calves	0.032 (0.072)	0.071 (0.034)*
Dietary diversity	-0.58135 (0.62645)	-0.90698 (0.55833)
Food spending	-0.6524 (13.0113)	0.0592 (1.5728)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

Table 4
Drinking water community effects

<i>Variable</i>	<i>Propensity score estimate</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	-80.145(109.838)	-113.023 (109.399)
Household non-agricultural income (GEL)	-430.28 (1307.72)	-619.89 (1093.55)
Moving about baseline bottom quartile	0.083667 (0.468520)	0.52188 (0.63835)
Principal component of physical asset wealth	0.071680 (0.095109)	-0.135396 (0.118821)
Drinking water system	2.91056 (0.72961)***	2.17393 (0.63778)***
Time to fetch drinking water	2.1392 (2.2065)	3.2941 (2.4171)
Dietary diversity	0.44408 (0.26937).	0.33981 (0.18404).
Food spending	1.6804 (102.8161)	0.8046 (0.5989)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

Table 5
Leasing component effects

<i>Variable</i>	<i>Propensity score estimate</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	2381.40(1121.66)*	4173.01 (1358.51)**
Household non-agricultural income (GEL)	646.08 (611.55)	972.54 (716.37)
Moving about baseline bottom quartile	-0.19799 (0.28877)	0.71841 (0.36367)*
Principal component of physical asset wealth	-0.133309 (0.078697).	-0.180228 (0.081118)*
Dietary diversity	-0.11617 (0.26125)	-0.06400 (0.26545)
Food spending	0.2739 (0.8856)	0.2231 (0.1806)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

Table 6
Female headed household effects

<i>Variable</i>	<i>Propensity score estimate</i>	<i>Genetic matching estimate</i>
Household agricultural income (GEL)	-117.339 (93.011)	-73.686 (185.314)
Household non-agricultural income (GEL)	-453.18 (575.97)	-391.67 (551.31)
Moving about baseline bottom quartile	1.50497 (0.95792)	0.33898 (0.80688)
Principal component of physical asset wealth	0.123409 (0.099311)	0.068829 (0.136116)
Cows	NA	NA
Calves	NA	NA
Drinking water system	NA	NA
Time to fetch drinking water	NA	NA
Dietary diversity	-0.61661 (0.48278)	0.25253 (0.46176)
Food spending	-0.3622 (0.8521)	-0.1152 (0.5564)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

Table 7
Entire sample effects

<i>Variable</i>	<i>Exponentiated propensity score matching</i>	<i>Exponentiated GEN</i>
Women's role in decisions related to asset purchases	1.2699 (0.15984)	1.3099 (0.27058)
Women's role in decisions related to what agricultural products are produced	1.0652 (0.160826)	0.8740 (0.23084)
Women's role in decisions related to which agricultural products will be sold or given away	1.1802 (0.19048)	1.0260 (0.266729)
Women's role in decisions related to planting and taking care of the land.	0.5523 (0.31058)	0.5537 (0.40534)

***p<0.001; **p<0.01; *p<0.05.

Estimates are presented with clustered standard errors in parentheses.

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