Investing in rural people

IMPACT ASSESSMENT PLAN

Federal Democratic Republic of Nepal

High Value Agriculture Project in Hill and Mountain Areas (HVAP)

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Kafle, K., and Songsermsawas, T. 2018. Impact Assessment Plan: High Value Agriculture Project in Hill and Mountain Areas (HVAP), Nepal. Rome: IFAD. 30 Pages

Acknowledgements

The authors wish to thank Lakshmi Moola, Bashu Aryal, and IFAD's Country Office team for Nepal for their comments and suggestions. We are also grateful to Paul Winters, Romina Cavatassi, Alessandro Garbero, Rui Benfica, Fabrizio Bresciani, and Eva-Maria Egger from IFAD, and Robert Pickmans from University of California, Berkeley for their helpful comments. We are thankful to the staff members of the High Value Agriculture Project in Hill and Mountain Areas (HVAP) for their feedback as well as technical and logistical support during our field visits. In particular, we owe gratitude to the Project Director Rajendra Bhari, Krishna Thapa, Khim Oli, Renu Chamling Rai, Madhuban Shrestha, Keshav Karki, and Ramesh Thapa. We are also grateful to staff members from the Ministry of Agriculture, Land Management and Cooperatives (MoALMC), in particular Shyam Prasad Poudel, for their feedback.

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1. Introduction

Nepal's agricultural sector accounts for approximately 29% of its total GDP and more than half of its total value of exports (Government of Nepal, 2017).While the number of the Nepalese population living below the national poverty line has declined from 31% in 2004 to 25% in 2011, this reduction in poverty is to a large extent due to inflows of remittances from migrated household members working abroad (Chakravarty et al., 2016).[1] Improving agricultural productivity and creating opportunities to increase farm income are crucial to moving smallholder farmers out of poverty. However, this pathway is often constrained by lack of access to infrastructures, resources, and markets.

Central to the development constraints facing the land-locked country is its geographical attributes. In addition to being land-locked, Nepal is largely characterized by mountainous and hilly terrain which represents approximately 80% of the country's total land area (Savada, 1991). Approximately half of Nepal's total population live in these areas, whose livelihood mainly consists of traditional subsistence agriculture (Sharma, 2006). The rugged terrain poses challenges to the availability of arable land for agricultural production and the implementation of rural investment projects aimed at improving productivity and improving access to markets and services of smallholder households living in the mountainous and hilly areas of the country (Khadka, 1998; Deraniyagala, 2005).

The High Value Agriculture Project in Hill and Mountain Areas (HVAP) is a Government of Nepal's (GoN) project that IFAD has supported through a US$15.3 million loan and grant (from the total project cost of US$ 18.7 million) that aims to address the development challenges in rural areas in Nepal. HVAP covers seven districts of then mid-Western Development Region (now Karnali Province). It is a value chain development project designed to contribute to poverty reduction and improved food security through increased productivity of high-valued agricultural crops and livestock. The intervention focuses in facilitating the linkages between different value chain actors such as agribusinesses and producers; enhancing market access through infrastructure development such as marketing facilities, storage facilities, roads, and irrigation; and providing skill development and awareness training on multiple themes including business literacy, entrepreneurship, marketing strategies, agricultural production, gender balance, and social inclusion. The project started implementation in February 2011. The project is expected to complete its implementation activities in September 2018.

The main goal of HVAP is to reduce poverty and social inequality and improve food security in the most challenging rural hilly areas of Nepal through developing *inclusive value chain development* and *service market strengthening*. HVAP's main objective is fully aligned with Nepal's Agriculture Development Strategy (ADS) 2015 to 2035 (Government of Nepal, 2015) which aims to enhance agricultural productivity in rural areas by promoting high-valued agricultural production. Specifically, the HVAP interventions contribute directly to two highly coveted programs under the Agriculture Development Strategy; the Decentralized Science, Technology and Education Program and Value Chain Development Program.

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[1] The national poverty line of Nepal is defined at 19,261 Nepalese rupees (Rs.) per capita per year (ADB, 2013), which is equal to approximately US$190 per capita per year at the market exchage rate in February 2018.

Based on the supervision reports and annual outcome surveys, HVAP interventions has been regarded as a highly successful intervention, particularly in terms of increasing linkages between farms and markets of high-valued crops and livestock. To that end, IFAD and the Government of Nepal have agreed to scale up the project to include a larger geographical area, larger number of beneficiaries, and a greater number of value chains. The scaled-up intervention of HVAP is called the Agriculture Sector Development Program (ASDP). ASDP was approved by IFAD's Executive Board in December 2017, and entered into force in February 2018. The success of HVAP interventions are confirmed also by anecdotal evidence and case studies conducted in the region, but have yet to be examined. In this light, this document presents a plan to conduct an ex-post impact assessment of HVAP to carefully assess and estimate the impact of the intervention. The aim of this impact assessment is to report on key outcome indicators identified in HVAP's logical framework and rigorously examine the impact of the intervention on those indicators. As ASDP is in its early phase of implementation, it could benefit from a validation of which of HVAP's impact pathways has been more effective. The key outcome and impact indicators of interest in this impact assessment relate closely to the IFAD's Strategic Goal and Objectives (SOs):

- increased economic mobility (Goal),
- increased agricultural productive capacity (SO1),
- strengthened linkages between smallholder farmers and agricultural markets (SO2), and
- greater environmental sustainability and climate resilience (SO3).

The goals and strategic objectives form the basis of IFAD's Results Measurement Framework (RMF) and this impact assessment exercise is guided by the RMF. This impact assessment aims to produce robust estimates of both direct and indirect impacts of HVAP on various livelihood domains, as captured by the outcome and the impact indicators of the target population along with the other indicators listed in the Project Completion Report (PCR) guideline and proposed by the government and project staff members. In so doing, this specific exercise involves both quantitative and qualitative data collection in the seven project districts, among both project beneficiaries and non-beneficiaries.

Furthermore, this impact assessment should also serve as a means to evaluate the extent to which HVAP interventions that lead to changes in outcome and impact indicators are consistent with the project's logical framework. Impact assessments are important for policy makers, donors, and researchers alike because they provide evidence to gauge accountability and attribution of the underlying intervention, and help generate lessons for future project design and implementation (Gertler et al., 2016). The proposed impact assessment is relevant to the implementing institutions at the regional, national, and international levels, and for the general public interested in rural agricultural development. Even though a significant proportion of development budget of governments and international donors goes to agricultural development, little has been done to carefully assess the impact of such interventions (Winters et al., 2010; World Bank, 2011). International agencies including the World Bank and the Inter-American Development Bank (IDB) have called for more rigorous assessments of agricultural projects (IDB, 2010; World Bank, 2011). Since inclusive rural transformation though agricultural development is one of IFAD's main goals, assessing the impact of agricultural interventions has been a top priority. This exercise constitutes a part of impact assessment portfolios that will be used to assess the overall impact of IFAD's projects throughout the world. It also contributes to IFAD's effort to generate a critical mass of evidence on impact of agricultural interventions geared to enhance economic development via improved agricultural transformation.

To address the growing demand of rigorous impact assessments of agricultural interventions, IFAD has commissioned the IFAD9 Impact Assessment Initiatives (IFAD9 IAI) to generate evidence of success of IFAD-supported projects starting in 2012. To this end, the Research and Impact Assessment Division (RIA) within the Strategy and Knowledge Department (SKD) at IFAD, provides technical support to the Programming and Management Department (PMD) to mainstream impact assessments into IFAD-supported projects, and build government capacity for evidence-based policy making. As part of the Tenth Replenishment of IFAD resources (2016-2018), IFAD will continue to commit to conduct rigorous impact assessments with ex-ante and ex-post evaluation designs through IFAD10 IAA.

The rest of this document is organized as follows. First, in Section 2, we present HVAP's theory of change (TOC) including background of the project, targeting criteria and geographical coverage, relevant research questions, and relevance of this impact assessment to existing literature. In Section 3, we present the sampling strategy to be used to collect the required data, sampling frame, and sample size calculations. In Section 4, presents the impact assessment design including estimating model and key impact indicators. Finally, we present estimated budget and proposed timeline for this impact assessment exercise in Section 5.

2. Theory of change and research questions

2.1 Theory of change

HVAP intervention is one of the ongoing efforts to address Nepal’s development challenges by developing inclusive value chains in mountainous and hilly areas. The project targets producer organizations (POs), which are mainly pre-existing groups or cooperatives locally formed for agricultural production, microfinance, marketing, or user right groups. Figure 1 summarizes the theory of change for the HVAP project which illustrates the causal mechanism that shows how project impacts emerge from inputs and activities. The theory of change closely follows the project logical framework and has been widely discussed with field staff and the project management unit (PMU). HVAP’s inputs and activities comprise of two components: (1) inclusive value chain development, and (2) service market strengthening.

In the literature, earlier theoretical works conceptualize the role of the transactions costs as market frictions that prevent smallholder farmers from participating in formal value chains (de Janvry et al., 1991: Key et al., 2000). Thus, policies or interventions that may reduce the transactions costs farmers face when marketing their crops may help improve farm revenues, and thus have a direct implication on welfare outcomes (Besley and Burgess, 2000; Barrett, 2008; Chamberlin and Jayne, 2013).

The project supports seven value chains including six high-valued crops and meat goat. The six high-valued crops include apple, ginger, vegetable seeds off-season vegetables, turmeric, and timur (Sichuan pepper). As part of the inclusive value chain development, the project helps to establish contractual agreements between producer groups and agribusinesses; facilitates business to business connection such as a linkage between small traders with large traders; and provide capacity and skill development trainings (such as credit mobilization, business literacy) to producers and traders. Under the first component, HVAP also provides support to enhance processing and market facilities and strengthen institutional capacity by providing market information, support services, and infrastructures e.g. collection centres, cold storages, etc. Previous studies have shown that linkages between farmers and traders, and as well as between small traders and large traders can help increase market access and value chain participation (Michelson et al., 2012; Barrett et al., 2012; Wang et al., 2014). Further, existing evidence has indicated that market linkage interventions are more likely to succeed if sufficient support is provided through all stages in the value chain (Ashraf et al., 2011; Cavatassi et al., 2011; González-Flores et al., 2014).

The project also supports activities to assure gender and social representativeness such as awareness trainings on social inclusion and gender balance**.** Under the service market strengthening component, the project provides technical training and market information to service providers e.g. agro-vets, trader associations, and agribusinesses.

These inputs and activities are expected to benefit project beneficiaries in the following ways. First, the established or strengthened linkages between farmers and markets, and between small and large enterprises should reduce the transactions costs farmers face when marketing agricultural produces (Key et al., 2000). Second, as a result of various capacity building and skill development training related to agricultural and livestock production and marketing, agricultural productivity is expected to increase and producers can expect to receive better prices for their agricultural produces (Davis et al., 2012; Emerick et al., 2016; Kondylis et al., 2017; Verkaart et al., 2017). Third, establishing or upgrading market structures such as collection centres and cold stores helps to stabilize market prices and reduce vulnerability (Mu and Van de Walle, 2011). Finally, the social inclusion and gender balancing approach of the project helps to empower women and marginalized population, enhance social capital, increase social support, and reduce social inequality within the project communities.

The impact pathway illustrated in the theory of change operates under various assumptions that may or may not be testable directly with empirical data. For example, HVAP's inputs and activities lead to outputs if and only if there is sufficient demand for high-valued crops and livestock produce, agribusinesses are able and willing to purchase and trade the items, and sufficient fertile land is available for crop and livestock production. The project outputs lead to outcomes if beneficiaries take up the intervention by responding positively to services delivered, utilizing opportunities to improve productivity, and using access to markets and service providers for buying inputs and selling outputs. In addition, outputs may not lead to outcomes if agricultural technologies and capacity building and skill development training delivered by the project are not adopted. For the outcomes to lead to project impacts, it is assumed that input, credit, and output markets exist and function well, other barriers in agricultural production such as adverse weather conditions or crop diseases are minimal, and land markets function well. It is also assumed that the project implementation agency would be able to provide reasonable and sufficient support to beneficiaries throughout the project duration. In our context, these assumptions are critical to HVAP's success, as input, credit, and output markets highly depend on the access to rural infrastructures and services, which might still be lacking in many areas of rural Nepal.

2.2 Some considerations about HVAP's TOC

Even though different project components may provide distinct causal channels for changes in the outcomes at both household- and PO-levels, it is imperative to recognize and understand both how different project activities and interventions interact and complement each other and how these interactions are related to potential observed changes in outcome and impact indicators. Having a clear idea of how project components interact allows researchers to design the surveys to collect comprehensive outcome and impact indicators that are not so obvious but implicit in the project logic. For example, providing real-time, accurate market information through improved linkages between farmers and markets allows farmers increase agricultural revenue by accessing markets at the right time to receive higher prices. Similarly, project activities that work to strengthen producer groups can also lead to improved individual empowerment, increased agricultural productivity, and better social inclusion through group members' increased awareness and capacity development. In addition to the interactions between project components, activities in the project areas can spillover to nearby areas leading to unintended positive or negative impacts.

There are two important considerations required to capture any spillover effects in an impact assessment framework; (1) the nature of spillover effects that could arise from project interventions, and (2) the mechanism through which the spillover effects emerge. Both the nature and mechanism of spillover effects influence the impact assessment design and underlying identification strategy. In our setting, HVAP project activities may increase demand for agricultural labour from non-beneficiaries through improvements in rural infrastructures and enhanced marketing linkages (Headey et al., 2010; Mu and Van de Walle, 2011). Another source of spillover is knowledge or skill spillover; farmers who receive training from the project may share the knowledge with their peers outside of project areas. Given the difficulties in access to frequent transportation and communication, we anticipate that the extent of knowledge spillover is minimal and that it should not be a major concern in this impact assessment (Witt et al., 2008; Songsermsawas et al., 2016).

Figure 1: HVAP's theory of change

INPUTS AND ACTIVITIES

Inclusive value chain development

- Establish contractual agreements between producer groups and agribusinesses
- Establish business to business linkage facilitation e.g. link small traders with large traders
- Strengthen institutional capacity by providing market information, support services, and infrastructures e.g. collection centers, cold storages
- Provide capacity and skill development trainings to producers e.g. credit mobilization, business literacy
- Assure gender and social representativeness
- Provide awareness trainings on social inclusion and gender balance

Service market strengthening

- Provision of technical training and market information to service providers e.g. agro-vets, trader associations

OUTPUTS

- Value chain for high-valued agricultural products established and strengthened
- Contractual agreements between producer groups and agribusinesses signed
- Small and large traders linked
- Market infrastructures such as storage and processing facilities established or upgraded
- Regular market information delivered to producers
- Women's and marginalised groups' participation in high-valued agricultural production increased
- Service providers' capacity strengthened
- Service providers' knowledge of market conditions improved

OUTCOMES

Household Level

- Higher yields of crops and livestock produced
- Higher values of crops, livestock, livestock products sold
- Increased agricultural employment
- Reduced vulnerability to production and climatic shocks
- Cultivation area increased

PO Level

- Increased number of small-scale producers and traders in local markets
- Increased volume of transactions in local markets
- Increased participation of women and marginalized people in social functions
- Increased number of storages accessible to farmers

IMPACTS

Household Level

- Increased agricultural productivity
- Increased income
- Increased assets
- Greater empowerment of women and marginalized groups
- Improved food security and dietary diversity
- Improved resilience to production and climatic shocks
- Differential migration and remittance levels

PO Level

- Improved market access
- Improved service and infrastructure access
- Enhanced local agribusiness capacity
- Improved local food economy
- Enhanced social capital

ASSUMPTION

Inputs and activities:

- There is sufficient demand for high-valued agricultural products.
- There are agribusinesses that accept high-valued agricultural products.
- There is enough fertile land for high-valued crops.
- There is sufficient grazing land for livestock.

Outputs:

- Beneficiaries respond positively to project interventions and activities.
- There is a positive response to opportunities to improve agricultural productivity and markets.
- Training activities are appropriate and will lead to adoption of technology and practices.

Household Level

- Markets for inputs, credit, and outputs exist and function well.
- Farmers face no other barriers to improving agricultural outcomes such as weather conditions or crop diseases.
- Land formalization reduces transactions costs of investing in production capital.

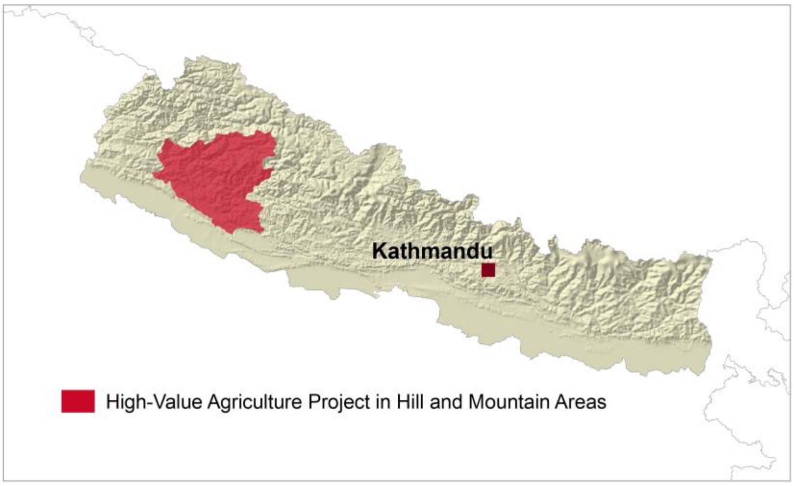
PO Level

- The project's implementation agency is able to provide reasonable and sufficient support to POs.

2.3 Project coverage and targeting

HVAP interventions cover seven districts from Mid-Western Development Region (Karnali Province in the newly adopted system). The project works with producer organizations (POs) and a total of pre-existing 467 POs (which consist of groups and cooperatives) in 126 village development committee (VDCs) are covered. Figure 2 shows HVAP coverage area on the map of Nepal.

Figure 2: HVAP project areas on the map of Nepal



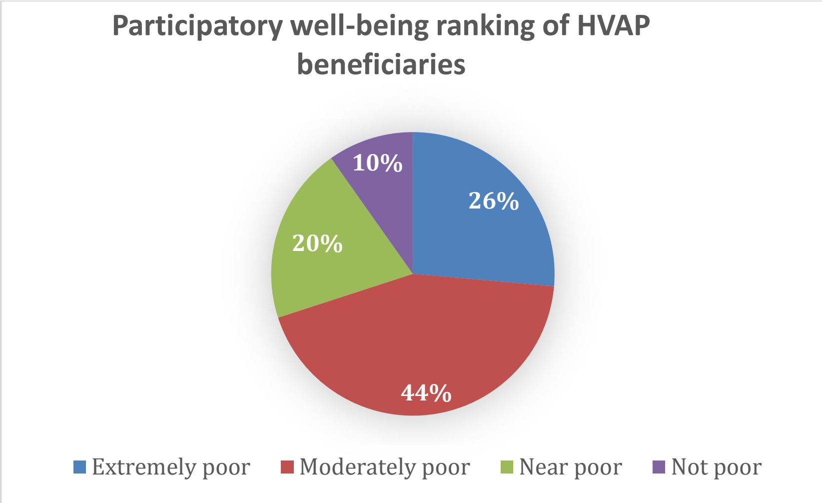
In Table 1, we present the number of local governing bodies (VDCs in rural areas and Municipalities in town or cities) in each district covered by HVAP. VDCs and municipalities are administrative units and therefore are mutually exclusive. Each VDC contains multiple POs. Since membership in a producer organization is optional and depends on scores of factors, only a subset of the VDC population is covered by POs. HVAP covers a total of 126 VDCs, 467 POs, and 15658 households.

Table 1: Number of VDCs, POs, and households covered by HVAP

District	VDCs	POs	Households
Achham	8	26	928
Dailekh	28	63	2,097
Jajarkot	12	60	2,826
Jumla	19	60	1,466
Kalikot	13	62	1,811
Salyan	10	45	1,176
Surkhet	36	151	5,354
Total	**126**	**467**	**15,658**

According to the project-level database, HVAP has benefitted approximately 15,658 households, which consists of 101,959 people. The distribution of the beneficiary households according to their well-being ranking is illustrated in Figure 3.[2]

Figure 3: Well-being ranking distribution of HVAP beneficiaries



Based on our review of HVAP project documents and our discussions with project staff, the targeting criteria to select POs and households to participate in HVAP interventions include the following eligibility rules:

Table 2. HVAP project targeting criteria

Targeting criteria	Eligibility rule
Travel time to markets (one-way)	
< 3 hours	Eligible for fresh vegetables
3 - 6 hours	Eligible for ginger, turmeric, apple
6 - 12 hours	Eligible for goat, timur, vegetable seeds
Well-being ranking	Eligible if households fall into first three categories: extreme poor, moderately poor, and near poor
Income level	Eligible if per capita income is less than Rs. 2,000 a year
Landholding size	Eligible if landholding size is 0.5 Ha or less per household

2.4 Value chain coverage by districts

As mentioned in the introduction section, the HVAP project supports seven different value chains – six crop value chains and a livestock (goat) value chain. However, no project district received

[2] The well-being ranking is determined based on a participatory approach at the community level, where community members have an active role in validating the well-being ranking of each household within the community.

support for all seven value chain due to eligibility criteria and agro-ecological differences. Table 3 provides an overview of value chain coverage by project districts. Kalikot received support for the least number of value chains – apple, goat, and off-season vegetables – and Salyan and Surkhet both received support for the highest number of value chains – all but apple value chain. Similarly, Apple value chain is supported only in two districts – Jumla and Kalikot – because other districts are less favorable for apple production. Goat and off-season vegetables are supported in all 7 districts but the varieties of vegetables and species of meat goat supported differ by district according to its agro-ecological condition.

Table 3. Value chain coverage by district

Districts	Apple	Ginger	Goat	Off-season vegetables	Timur	Turmeric	Vegetable seeds
Achham			x	x	x	x	
Dailekh		x	x	x		x	x
Jajarkot			x	x	x		
Jumla	x		x	x			x
Kalikot	x		x	x			
Salyan		x	x	x	x	x	x
Surkhet		x	x	x	x	x	x

Notes: HVAP project value chain coverage by district. There are 31 unique district-value chain combinations.

Potential differences in project supported value chains across different districts provides a unique opportunity to disaggregate the project participants by district-value chain combination. The district-value chain combination allows us to tease out the differential impacts of the intervention by both districts and type of values chains. Because no project district is covered by all seven value chains supported by HVAP, there are only 32 unique combinations of district-value chain pair. Table 4 presents the distribution of POs, villages, households, and population by the district-value chain pair.

Table 4. Project coverage details by 'district-value chain' pair

District	Value chain	POs	Households	Population
Achham	Goat	8	310	2355
Achham	OSV	11	370	2683
Achham	Timur	2	80	501
Achham	Turmeric	5	168	1044
Dailekh	Ginger	1	50	277
Dailekh	Goat	20	723	5624
Dailekh	OSV	35	1073	9553
Dailekh	Turmeric	6	189	1346
Dailekh	Vegetable seeds	1	62	511
Jajarkot	Goat	23	580	3486
Jajarkot	OSV	17	342	1778
Jajarkot	Timur	12	1482	11276
Jajarkot	Turmeric	8	422	2404
Jumla	Apple	39	1055	6563
Jumla	Goat	4	95	610
Jumla	OSV	12	148	904
Jumla	Vegetable seeds	5	168	947
Kalikot	Apple	30	958	6521
Kalikot	Goat	15	424	3294
Kalikot	OSV	17	429	2836
Salyan	Ginger	9	299	1876
Salyan	Goat	14	313	1948
Salyan	OSV	9	196	1185
Salyan	Timur	5	123	710
Salyan	Turmeric	7	225	1337
Salyan	Vegetable seeds	1	20	134
Surkhet	Ginger	36	1135	6637
Surkhet	Goat	37	1218	7178
Surkhet	OSV	48	1523	8286
Surkhet	Timur	4	578	3362
Surkhet	Turmeric	19	700	3846
Surkhet	Vegetable seeds	7	200	947
Total		**467**	**15,658**	**101,959**

Notes: OSV stands for off-season vegetables and VS stands for vegetable seeds.

2.5 Research questions

Based on the project theory of change illustrated in Figure 1, this impact assessment will answer a number of research questions. The main research questions we seek to answer in this impact assessment are as follows, which are presented in the order of project logic from inputs/activities, outputs, outcomes, and impacts.

1. Does the intervention help to reduce poverty among project households? How did the intervention lead to reduced poverty rates?
2. Do households in project areas benefit from greater access to market infrastructures? Specifically, do they have greater access to collection centres, cold storages, or other market-related facilities?
3. Does the intervention lead to higher levels of technology adoption, and use of complementary cash inputs (e.g. fertilizer, pesticide, and other improved crop cultural practices)? Similarly, are households in project areas more likely to use improved livestock management practices (e.g. improved sheds, drenching, vaccination, and other veterinary services)?
4. Does the intervention improve beneficiary households' access to information about agricultural production, markets, and prices?
5. Does the intervention improve access to credit, other rural financial services, and insurance services?
6. Is the agricultural yield and revenue for project households higher than control households? What leads to the higher yields; higher levels of technology adoption, or use of complementary inputs, or improved livestock management practices?
7. Do the intervention help to improve dietary diversity and food security situation among recipient households?
8. Does the intervention contribute to improve women's decision-making within project households and communities?
9. Are project households more resilient to negative exogenous shocks than non-project households? Specifically, are able to recover from shocks better than non-project households?

3. Impact assessment design

3.1 Identification strategy

A good identification strategy is vital to identify the treatment effects of the intervention by eliminating potential confounding factors. Since the program placement is non-random, identification of the treatment effects can be more challenging. Given that no baseline data is available, identification of the treatment effects can get tricky. We will use multiple methods to estimate the average treatment effect (ATE) and the average treatment effect on the treated (ATT). ATE is the average effect of the intervention on general population, people that are covered by HVAP as well as those outside of project areas, but ATT is the effect of the intervention on those who are covered by the project. If program placement is completely random, then both ATT and ATE will be identical. In our case, since HVAP intervention were not randomized and project beneficiaries likely influenced program placement – self-selection into treatment – ATT and ATE estimates are expected to be different. Our primary interest is on ATT but we also estimate ATE to be able to make inference on the impact's external validity.

First, we will use matching methods such as propensity score matching (PSM) to estimate ATE and ATT. We will then use regression based methods to estimate the treatment effects. Finally, we will use doubly robust method that combines the matching and regression based methods to estimate the treatment effects. While our preferred method is the doubly robust method, we will compare the results across all three methods to confirm the robustness of our results.

3.2 Estimating models

Our analysis focuses mainly on ATT or the impact of the HVAP intervention on project households. We will begin the analysis with the propensity score matching (PSM) method.[3] In the PSM framework, the impact of the project (T_i) on household i can be written as follows:

$$\delta_i = \frac{Y_{i1}}{m_i} - \frac{Y_{i0}}{m_i},$$

where δ_i is the impact of the project (or average treatment effects), Y_{i1} refers to the outcome of interest for project household i, Y_{i0} is the outcome of interest for household i in the absence of the project, and m_i is the number of observations in each cluster (in our case $m_i = 12$). Treatment effects on the treated (ATT) can be estimated using following expression:

$$ATT_{PSM} = E(\delta_i | T = 1) = E(Y_{i1} - Y_{i0} | T = 1) \quad (1)$$

In this framework, the key identifying assumption is the conditional independence assumption (CIA) which assumes that the treatment status is independent of the outcomes of interest, contingent on the observable characteristics (Rosenbaum and Rubin, 1983). Mathematically, if X_i is a vector of observable characteristics, then $T_i \perp (Y_{i0}, Y_{i1}) | X_i$.

To supplement the PSM results, we also employ regression-based analysis to consistently estimate treatment effects while controlling directly for selection into project participation based on observable characteristics. Our regression method will be similar to the one used in Godtland et al. (2004) to estimate the impact of farmer field schools on the returns to potato production in Peru, and in Rejesus et al. (2011) to estimate the impact of an improved irrigation technology on rice production in The Philippines.[4] Specifically, the regression specification is as follows:

$$Y_i = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \delta(\boldsymbol{X}_i - \overline{\boldsymbol{X}})T_i + \varepsilon_i \quad (2)$$

where Y_i is an outcome of interest, $\boldsymbol{X}_i$ is the vector of observable characteristics of household i, $\overline{\boldsymbol{X}}$ is the vector of the average of the observable characteristics of household i, and ε_i is the error term. In Equation (2), β is the ATE estimate. Replacing $\overline{\boldsymbol{X}}$ with $\overline{\boldsymbol{X}}_1$ (where $\overline{\boldsymbol{X}}_1$ is the average over treatment households only) gives us the ATT estimate.

Finally, to complement the two approaches described above, we plan to estimate the impact of HVAP by doubly robust methods such as the inverse-probability-weighted regression-adjustment (IPWRA) estimator (Wooldridge, 2007; Wooldridge, 2010). This approach models the likelihood of being treated by an intervention and estimates the impact from participating in the intervention. A major advantage of this estimation approach is that only one of the two estimation equations needs to be specified correctly, and thus has the “double-robust” property. This method follows the similar approach as the regression-based method. However, each observation in the dataset is assigned weights according to the following matrix:

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[3] To ensure that our PSM results are robust to different specifications, we employ alternative matching approaches to validate the PSM results.

[4] See also Wooldridge (2010) for more details about this approach.

$$\omega(t,x) = t + (1-t)\frac{\hat{P}(X)}{1-\hat{P}(X)},$$

where $\omega(t,x)$ is the weight applied, t represents $T_i = 1$, $\hat{P}(X)$ is the estimated propensity score, and X is a vector of covariates.

Table 5 summarizes the models we will use to estimate the treatment effects of the HVAP intervention. Note that *i* denotes household, T denotes treatment indicator (1 if in the HVAP sample and 0 otherwise), Y_i denotes outcome of interest, X_i is a vector of observable characteristics.

Table 5. Identification strategies and treatment effect models

Method	Treatment effects	Formula
Propensity score matching	ATT	$E(Y_{i1} - Y_{i0} \mid T = 1)$
	ATE	$E(Y_{i1} - Y_{i0})$
Regression based method	ATT	$Y_i = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \delta(\boldsymbol{X}_i - E[X_i \mid T_i = 1])T_i + \varepsilon_i$
	ATE	$Y_i = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \delta(\boldsymbol{X}_i - \bar{\boldsymbol{X}})T_i + \varepsilon_i$
Doubly robust method	ATT	$Y_i = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \delta(\boldsymbol{X}_i - E[X_i \mid T_i = 1])T_i + \varepsilon_i$ with weights $\omega(t,x) = t + (1-t)\frac{\hat{P}(X)}{1-\hat{P}(X)}$
	ATE	$Y_i = \alpha + \beta T_i + \gamma \boldsymbol{X}_i + \delta(\boldsymbol{X}_i - \bar{\boldsymbol{X}})T_i + \varepsilon_i$ with weights $\omega(t,x) = t + (1-t)\frac{\hat{P}(X)}{1-\hat{P}(X)}$

3.3 Differential impacts

Project design report for HVAP indicates that eligibility criteria differ by the type of value chain, wellbeing ranking, and ethnicity. In addition, project beneficiaries received support services and project benefits at different points in time creating heterogeneity in program placement. After estimating ATE and ATT for the intervention, we will estimate the impact of the intervention for various sub-groups by teasing out the differential timeline for project placement and the heterogeneity among beneficiaries, as the project's M&E data contain detailed information when HVAP interventions were rolled-out in each PO.

3.4 Constructing counterfactual groups

An appropriate identification of valid counterfactual groups requires a sound understanding of project implementation and eligibility criteria. HVAP's interventions and activities were implemented at the PO level. A PO is either a group of about 25 farm households or a cooperative consisting multiple groups. Each PO focuses only one specific crop or livestock. HVAP covers 467 POs across seven districts and among them are 331 groups and 136 cooperatives. The eligibility criteria for HVAP interventions and activities are multifaceted: the project specifically targets socially vulnerable populations including women, *dalits* (lower caste groups), *janajatis* (indigenous peoples), and poor and marginalized farmers. The eligibility criteria also differed by the type of value chain and the well-being status of beneficiaries.

As the project does not employ a staggered roll-out approach, and all households in HVAP-supported POs receive support services simultaneously, finding a good counterfactual to represent the scenario of households in HVAP-supported POs in absence of HVAP is challenging. Assuming each district has a pool of qualified villages and households possessing similar characteristics with those of project villages and households, we use village-level propensity score matching to find counterfactual villages outside of the project area but within the same district. For project villages in each district, the pool of potential control villages is restricted within the same district to assure geographical similarity and spatial proximity between project villages and potential control villages. We use the 2011 Population Census data to match project villages and potential control villages. Our matching will be based on 11 household demographic characteristics, and on asset ownership. Table 6 presents variables used in the matching. The datasets are publicly available from the Central Bureau of Statistics (CBS), Nepal.[5] The HVAP project management unit will help gather the required data from CBS, Nepal. Since we perform matching at the village level, all variables used in the matching are village-level averages. For example, the average number of households in a village with good quality floor, or average yields of vegetable by village. We will perform propensity score matching with 3-nearest neighbors match with replacement. The caliper length will be set at 0.1.

Table 6: Variables used in the village level matching

Matching variables	
Household size	Use of cooking fuel
Home ownership	Asset ownership
Quality of roof materials	Literacy rate
Quality of wall materials	Source of drinking water
Quality of floor materials	Source of energy
Access to sanitation facility	

Notes: All variables are village level averages. Data were obtained from publicly available database of the 2011 Population Census conducted by CBS, Nepal.

After best-matched control villages are identified, we will list all existing Producer Organizations (POs) in the control villages and use the project eligibility criteria and local knowledge to identify the best-matched counterfactual PO for each project PO.

3.5 Potential spillover effects

As mentioned in the section two (Theory of change section), the nature of the HVAP interventions (value chain enhancement activities) can generate spillover effects. Collecting detailed data from non-beneficiaries to investigate the presence of spillover effects would imply a larger sample size, which also has a direct cost implication. As we expect the HVAP interventions to have positive

[5] The village-level matching does not use agricultural variables because, despite availability of Agricultural Census data for 2011, village level averages were not available due to lack of identifying variables for villages.

spillover effects on non-beneficiary households and communities through enhanced value chain components, we will explore the extent of the spillover effects by using information mainly from qualitative surveys. In our setting, positive spillovers imply that it would be difficult to estimate project impact, which might result in downward bias estimates of the true project impact. The qualitative survey, to be discussed later, will consist of semi-structured interviews administered to key-informants from the project staff, farmers, PO leaders, traders, and business service providers.

4. Sampling and data collection

4.1 Sample size calculations

Choosing the right sample size is very critical to a successful impact assessment, i.e., one that possess sufficient statistical power to exhibit the impact of an intervention, should it exist. A number of factors affect the sample size but the level of expected change in the outcome of interest is the key. We use a method developed by the World Bank that incorporates expected minimum change in the outcome variable, its standard deviation, the critical values of the confidence interval and statistical power, and the minimum number of units to be sampled within each cluster (Winters et al., 2010; World Bank, 2007). Based on the discussions provided in Winters et al. (2010) and World Bank (2007), we use following formula to calculate the required sample size (N):

$$N = \frac{4\,\sigma^2 (Z_a + Z_\beta)^2}{D^2}[1 + \rho(m - 1)] \qquad (3)$$

where σ is the standard deviation of the baseline outcome variable, Z_a is the critical value of the confidence interval, Z_β is the critical value of the statistical power, D is the minimum expected change in the baseline average of outcome variable, ρ is the intra-cluster correlation (ICC) of the unit of analysis, and m is the number of units to be sampled within each cluster. The standard deviation (SD), and minimum expected change (D) are presented in Table 7. Among other parameters, we assume the analysis will have 80% statistical power and 95% confidence level so Z_a =1.96, and Z_a=1.28. Following the standard practice, we plan to sample at least 12 sampling units (households in this case) per cluster (m), and the ICC is assumed to be 0.05.

Table 7 presents the details of sample size calculation. Even though we assess the impact of HVAP intervention on several outcomes of interest, our sample size calculation is based on seven variables only. The variables include food security indicator, income level, vegetable productivity, rate of unemployment, and women’s empowerment. Ideally, these calculations would be done at the program implementation unit, i.e. POs in this case, but no baseline data was available at the PO levels and our calculation is based on district level average. As a consequence, the minimum expected changes are relatively small because these expected changes are for the entire district. Replacing the parameter value in Equation 3, we calculate the required sample size (N) for each outcome variable. We adjust the sample size for 15% margin of error that includes potential sampling error and spillovers. In general, the largest required sample size is chosen for sampling to assure that the sample is sufficient to achieve the expected effects. In this case the largest required sample size is 3,357 to detect the minimum expected change in meat goat production. However, due to our low confidence on meat goat production data, we use the second largest required sample size of 3,001 which is required to detect the minimum expected change in the poverty rate. The total sample size will be equally divided into two equal halves, where one half (1,500 households) will consist of project beneficiaries (also called *treatment group*), and the other half will consist of non-beneficiaries, (also called *control group*).

Table 7: Sample size calculation

Outcome variables	Average	SD	Minimum expected change*	D	N	1.1*N
Poverty rate (%)	43.5	11.3	4% (-)	1.74	2,728	3,001
Apple productivity (Kg./Ha.)	6,196.2	746.5	10% (+)	619.6	94	104
Vegetable productivity (Kg./Ha.)	13,375	3,159.4	5% (+)	668.7	1,453	1,598
Meat goat production (Mt./year)	1,474	2,018.6	20% (+)	294.8	3,052	3,357
Sample size					**2,728**	**3,001**

Note: *Symbols in the parantheseses indicate the directions of expected changes: increase (+) or decrease (-) Due to lack of data, different indicators are averaged over different geographic areas: Poverty rate is an average of five development regions; Apple yield is an average of village-level production in Jumla district (one of the districts covered by HVAP); meat goat production is an average over seven HVAP districts; and vegetable yield is an average of eight different districts across the country including four HVAP districts.

4.2 Sampling strategy

The HVAP project covers 14 Municipalities and 24 Rural Municipalities (126 VDCs and 2 municipalities in the old administrative system) across seven districts in Karnali Province[6]– Achham, Dailekh, Jajarkot, Jumla, Kalikot, Salyan, and Surkhet. The project covers 15,629 households and 101,959 individuals belonging to 467 POs. Seven different value chains are supported, but none of the project districts get support for all seven value chains. As the districts covered by HVAP are widely distributed across the Province, and each district differs from other districts in various aspects including composition of ethnic groups, agro-ecological conditions, and type of agricultural value chain, we employ a multi-stage stratified sampling to assure representative sample from all districts, and value chains. There are a total of 32 unique district-value chain pairs (for example Achham-Goat, Dailekh-Goat, Jumla-Apple etc.), and our sampling design accounts for such heterogeneity. Figure 4 presents our sampling design for project sample. A similar approach will be used for control sample selection also.

In the first stage, we stratify the project area to seven sub-populations (districts), and list all POs covered by HVAP in each district (Strata). First, we use the pre-determined project sample size and the minimum number of sampling units per cluster to determine the required number of clusters; that is dividing 1500 by 13 gives us the cluster sample size of 117, after rounding. As we have 467 clusters in total, the cluster sample represents 25.05% of the cluster population. To assure proportional representation of all clusters in the final sample, we sample 25.05% of clusters (POs) from each strata (District) by using simple random sampling with proportional allocation. This exercise gives us the distribution of the total of 117 project clusters across project Strata. To ensure sample balance, the number of control clusters will be exactly the same, i.e. 117 clusters from the project areas will be selected for the study. In the second stage, first we will list all the households in

[6] Note that Accham district is not in the Karnali Province. However, a few villages in Achham that are close to Karnali Province were covered by HVAP and make our universe of project population.

the selected clusters. Then, we will calculate the number of households to be sampled from each Strata (district) based on the number of sample households per cluster[7]. We will randomly select households from each selected cluster. As the required sample size (1,500) is not an exact multiple of cluster sample size (117), we are going to sample at least 12 to 13 households per cluster to meet the required sample size. We will then calculate sampling weight – an inverse of the probability of a sample unit to be selected in the final sample.

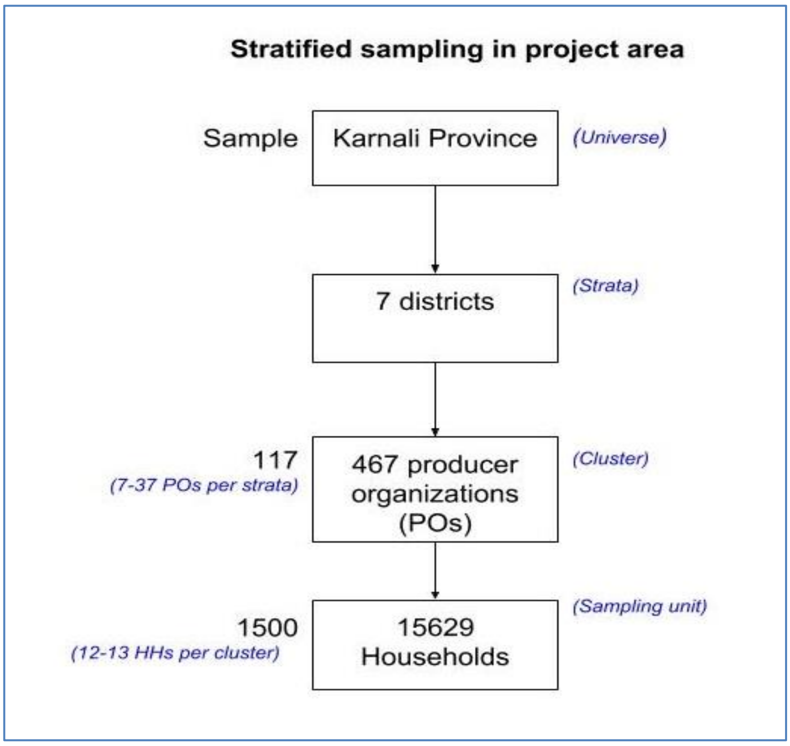

Figure 4: Sampling design for HVAP project areas

Table 8 presents the details of districts, municipalities, POs, villages, and households covered by HVAP. The final sample is believed to adequately reflect the underlying heterogeneity in project beneficiaries as it includes project beneficiaries from each district-value chain pair. For the control group, we will sample the same number of households outside of HVAP areas but within the same district. Counterfactual clusters will be chosen based on propensity score matching; for each district, best-matched clusters outside of project areas but within the same district will be chosen. The number of project and control households and clusters will be exactly the same with a total of 117 clusters and 1,500 households from 76 village development committees (VDCs) or villages from both project and non-project areas.

Based on the number of clusters to be sampled from each district, we will produce two sets of project clusters by randomly selecting the required number of clusters from each district twice. Project clusters in each random set will be accompanied by three potential control clusters chosen by using the propensity score matching approach. For each randomly selected project cluster, we will then identify the best matched control clusters with help from the PMU and HVAP social mobilizers who

[7] To make sure the total sample size does not exceed 3,000, we will sample 12 to 13 households per cluster.

work in the field. In this selection process, social mobilizers will organize a local meeting in each selected cluster to collect input from village leaders and other individuals, if needed.

Table 8: Sampling frame: districts, villages, and households

District	No. of VDCs	No. of POs	No. of HHs	Project Sample		
				VDCs	POs	HHs
1. Achham	8	26	928	4	7	88
2. Dailekh	28	63	2,097	12	17	217
3. Jajarkot	12	60	2,826	8	15	192
4. Jumla	19	60	1,466	6	15	192
5. Kalikot	13	62	1,811	7	15	194
6. Salyan	10	45	1,176	7	11	139
7. Surkhet	36	151	5,354	22	37	478
Districts	126	**467**	**15,658**	**76**	**117**	**1,500**

Note: There will be equal number of counterfactual POs and households in each district. Since 1,500 is not an exact multiple of 117, we sample 13 households per cluster from 24 POs of Surkhet and 9 POs of Jajarkot. These particular POs are chosen because they have higher population density than others

4.3 Households listing

As part of the impact assessement, we will conduct a detailed enumeation of households in treatment and control areas. Household listing is an imperative part of any household survey because having a current list of households in survey area allows us to randomly select required number of households from the eligible population. In this exercise, household listing will be done by the HVAP project by a few weeks before the household survey. In project area, the list of beneficiary households will be updated and used to draw 'treatment' sample. In control areas, households that would have been eligible for HVAP in baseline (meaning they are theoretically eligible to receive HVAP interventions but are located outside the areas covered by HVAP) but that were not considered the project will be identified and listed. Such list will be used as the sampling frame to randomly draw our control sample.

4.4 Key Indicators

We closely follow HVAP's logical framework, theory of change, impact assessment research questions, and IFAD's RIMS indicators to identify the outcomes of interest for this impact assessment. We measure impacts at both household and community levels. Indicators at the household level are grouped in two sub-categories – well-being status and agriculture. We also assess impact on some PO-level indicators. Table 9 presents our indicators of interest for this impact assessment.

The key indicators will be constructed based on information collected from a sample survey at both household and community levels. The quantitative survey will include a detailed survey of various aspects of the households and communities in the project areas. The household survey will consist following modules:

Table 9. Key impact indicators for HVAP project

Indicators	Short/medium/long run	Data source	Unit of analysis
Well-being:			
Income	Short/medium/long	Household level income data	Household
Asset ownership	Medium/long	Durable assets, livestock assets, housing characteristics	Household
Food and nutrition security indices	Medium/long	Household dietary diversity score (HDDS), Food Insecurity Experience Scale (FIES)	Household
Resilience and empowerment	Medium/long	Various shocks and coping strategies used. Decision-making power in household activities	Household
Access to goods and services	Short/medium/long	Access to good housing, sanitation, safe drinking water etc.	Household
Agriculture:			
Agricultural productivity and value of production	Short/medium	High-valued crops, and other crop productivity	Plot
Livestock ownership and value of production	Short/medium	Number and value of livestock owned	Household
Cropping pattern	Short/medium	Traditional or modern agriculture, fertilizer and pesticide used or not	Plot
PO-level outcomes:			
Access to markets	Short/medium/long	Community data on market institutions and distances to markets	PO
Women's empowemrent	Short/medium/long	PO-level data on women's group membership, leadership, and decision-making	PO
Social inclusion	Short/medium/long	PO-level data on group membership, leadership, and decision-making of ethnic groups	PO
Local agribusiness capacity	Short/medium/long	Community data on agribusiness capacity and resources	PO
Local food economy	Short/medium/long	Availability of food items and their prices	PO

4.5 Qualitative sample

In this impact assessment, we will collect qualitative data to gain additional information related to project targeting, implementation, market access and condition, and about the socio-economic and cultural context of the project areas. The qualitative survey to be used for HVAP will consist of key informant interviews (KIIs) and focused group discussions (FGDs). KIIs include interviews with selected key informants from POs, agricultural input suppliers, and agribusinesses or agricultural service providers (such as agro-veterinarians). We will conduct a total of 17 KIIs and 7 FGDs. Among 17 KIIs are seven interviews with PO leaders (one PO per district), five input suppliers and five agribusinesses in the HVAP area. The key themes of the KIIs will include questions about functionalities of the PO, the project's targeting strategy and implementation details, expected benefits from the project, market access and prices before and after the project, barriers to production and marketing of agricultural produces.

Unlike KIIs, FGDs will gather relevant information from a group consisting 6 to 10 people. We will conduct a total of seven FGDs that consist one FGD per district from each of the seven HVAP districts. Each FGD will be conducted at district level consisting one representative from each of the District line agencies (such as district agriculture development office, district livestock office, district chamber of commerce and industries etc.). Our qualitative instrument for both KIIs and FGDs will follow a semi-structured format to allow consistency of the questions asked to all participants. However, when necessary, the interviewers will be allowed to probe questions to ask for further details from the respondent.

4.6 Quantitative sample

We will administer two surveys as part of this impact study: a household survey (3,000 households) and a community survey (conducted at the PO level for a total of 117 POs). The household survey will collect information related to socio-economic characteristics including housing quality and asset ownership, agricultural and livestock production and sales, household consumption, household decision-making, access to markets and information, shocks and resilience, and environmental sustainability. We will randomly select a number of households in the project (treatment) and non-project (comparison) POs to be included in our surveys. The comparison households will come from non-project POs with similar baseline characteristics to the project POs, which resulted from both the first-level matching of POs and the consultations held with the PMU staff. The community survey will collect information related to the access to value chain, markets, infrastructures, and services. The community survey will be conducted at the PO level, and will contain information from the interviews with PO leaders and local PMO officers.

4.7 Complementary data

Apart from collecting quantitative surveys, we plan to supplement our survey data with additional observational data and administrative data. For observational data, we plan to collect detailed geographical information including the location and elevation of the households using GPS devices, the community centres, and the landmarks within each community.

In terms of administrative data, we obtain administrative data at the PO level which include information regarding the types of value chain supported, the number of beneficiaries, the amount of budget received from the project, and types of interventions offered in each PO.

5. Budget, deliverables and workplan

5.1 Planned budget

The data collection activities will be carried out by Lattanzio Monitoring and Evaluation (LME) srl based in Milan, Italy which has been selected after a competitive tender process. LME has proposed the following budget for the data collection activities (Table 10).

Table 10: Tentative itemized budget

Item	Proposed cost (US$)
Qualitative data collection	7,164
Pre-testing, enumerator training, and pilot	16,950
Quantitative data collection	179,887
Translation fees	746
Professional fees	36,796
Other fees	7,088
Administrative costs	19,890
Total	**268,521**

5.2 List of deliverables and workplan

As part of the impact assessment activities of the HVAP project, the associated deliverables, along with their tentative time to deliver those items, are shown in Table 10. At the completion of the impact assessment activities, we will produce three sets of main deliverables.

1. A set of presentations on the impact assessment methodologies, which introduces the concepts, requirements, and implementation plan, along with some key considerations about how to incorporate impact assessment into project design and implementation
2. Finalized household and community surveys and their cleaned datasets, along with an enumerator guideline explaining how to conduct field interviews using the surveys
3. An impact assessment report, which summarizes empirical findings from the analyses of household-level and community-level (PO-level) data and highlights key learning messages for future project design and implementation plan

Table 11: List of deliverables and their timeline

Item	Completion date
Review of project documents and IA preparation	January 2018
IA methodology training	February 2018
Data collection plan and secondary data analysis	March 2018
Household, community, and qualitative surveys drafting	April 2018
Enumerator training and pilot testing	May 2018
Data collection	July 2018
Data cleaning and data entry	August 2018
Preliminary IA analysis	September 2018
Validation of results to produce final IA report	October 2018

Table 12: Investigation team and main counterparts

<table>
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<tr><td>Kashi Kafle</td><td>Principal Investigator</td><td rowspan="2">RIA, IFAD</td></tr>
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<tr><td>Krishna Thapa</td><td>Monitoring & Evaluation Expert</td></tr>
<tr><td>Renu Chamling Rai</td><td>Gender, Social Inclusion and Group Development Expert</td></tr>
</table>

5.3 Validation of results and dissemination plan

Upon finishing the final impact assessment report, RIA will share the report with the PMU staff members and other key stakeholders to validate the results presented in the report. RIA will also work with other IFAD and PMU staff members to plan the dissemination activities of the findings from the impact assessment through various seminars, conferences, and workshops.

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