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REVITALIZING AGRICULTURAL EXTENSION SERVICES IN DEVELOPING COUNTRIES: LESSONS FROM OFF-SEASON VEGETABLE PRODUCTION IN RURAL NEPAL

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ABSTRACT

Technological advances in agriculture potentially can improve the productivity and income of farmers. However, it is unclear how rural and smallholder farmers can best learn about, adopt, and benefit from technological advances. Extension services with multiple linkages to organizations and farmers have been identified as a positive factor in successful adoption of new technologies. Participatory action research was undertaken in Kaski district of Nepal focused on introducing new (for the local context) technologies for off-season vegetable. The project sought to demonstrate best practices in agricultural extension and showcase a demand-driven, participatory, and pluralistic model of agricultural extension. It was hypothesized that doing so would enhance the productivity, income, and food security of participating rural households. Two household surveys were conducted -- a baseline survey in 2013 (before the project) and endline survey in 2015 (after the project) -- to collect data and study the impact of the intervention, if any, on household wellbeing. The results show the participatory approaches used to be associated with enhanced productivity, income, and food security for participant households. The results show that the area under off-season vegetable production, marketed vegetable volume, and income increased significantly. It appears that vegetable production and income tripled while the area of land dedicated to off-season vegetable production doubled at the end of the project. The types of crops grown by participant households also significantly increased over the project period. Furthermore, participant farmers were found to organize into groups for knowledge sharing, adopting new technology, and increasing household income. The results suggest that phase-wise learning and scaling up approach used in the off-season vegetable production can be replicated to disseminate new technologies in other contexts to strengthen extension service delivery.

Key words: Participatory action research, plastic tunnels/houses, pluralistic extension services

INTRODUCTION

Technological advances in agriculture seem to offer an opportunity to rural farmers to increase production and improve their livelihood sustainably. Adopting such technologies have contributed greatly toward the financial success of farmers through the efficient use of resources and scaling up the production at lower per unit cost. However, a majority of farmers in developing countries have not been able to adopt newly developed technologies because of their limited resources (cash, labor, time) and limited access to relevant information regarding the technology (Ghimire and Huang, 2015). Further, resource-poor farmers are often reluctant to invest in any untried technology because of their risk aversion behavior. In order to adequately address this issue, a good extension service delivery and strong linkages between farmers, extension, research and education are prerequisites (Rivera *et al*., 2009). Public sector agricultural extension, however, is not efficient and beyond the reach of the general clients (Carney, 1998; Hoffmann *et al*., 2000).

In least developed countries (LDCs) like Nepal, public extension systems are lagging behind other nations' evolving extension system. Nepal experimented with many models of agricultural extension services in the past and most of them had pervasive bias against small and marginalized farmers. Due to the cost ineffectiveness and lack of coverage, those extension approaches were unsustainable and did not serve well as a model for national agricultural extension. Moreover, the nature of large, hierarchically structured, conventional extension approaches is unable to respond effectively to predominately small and marginal farmers' needs. Such systems of 'extension' tend to follow top-down, supply-driven approaches rather than demand-driven service delivery model and historically have had their benefits and services captured by mostly elite groups or resource-endowed farmers. Traditional and top-down approaches of extension services are hindering the diffusion of innovations among farmers (Suvedi and McNamara, 2012). Being less cost-effective and financially unsustainable, these approaches are criticized and no longer preferred and fulfilled the general needs of resource poor farmers in the rural area.

A participatory and bottom-up system, market-driven or fee-for-service systems are emerging. These emerging approaches encourage pluralistic service delivery systems (multiple organization delivering service), and decentralization of programs/project's operation at the district and village levels. Decentralization helps address problems of different agro-ecological conditions as access to agricultural production systems and markets differ significantly across regions. This has, therefore, become an agenda to reform of public sector agricultural service provision in many countries where government extension services are criticized for being inefficient. The trend is to reduce the role of the state and to promote private enterprise (Hoffmann *et al*., 2000). Privatization or outsourcing of services to Non-Governmental Organizations (NGOs), Community-Based Organizations, and Farmer Organizations are in demand.

Over the last decade, there has been a general shift in thinking about extension systems: the former via of extension as a linear, technology transfer, 'adoption of innovations' approach has given way to a recognition of extension as a system of actors with multiple roles, a wide range of actors advancing an 'innovation system' (Sandall *et al*., 2011). This shift has influenced, and has been influenced by, shifts in policies toward supporting pluralistic provision of services that are more responsive to farmer demand (Garforth, 2011). Policy makers, service providers and academics increasingly are interested in finding out whether these changes have made differences in farmers' access to extension services that support their efforts to secure improved livelihoods for themselves and their families. This paper focuses on exploring how an innovation adoption system coupled with a participatory pluralistic agricultural extension effort in rural Nepal has affected those farming households.

Some studies have recommended developing and adopting a diversified and pluralistic national strategy to promote agricultural extension and communication to advance the livelihoods (e.g., food security and income generation) of poor people in rural areas (Ghimire and Huang, 2016; Rivera and Qamar, 2003). This can be viewed from two institutional levels: extension providers and clients of extension agencies. We developed a pilot action research activity in conjunction with USAID/MEAS and Michigan State University (MSU) in Kaski district of Nepal that focused on introducing off-season vegetable production. The effort was framed to explore the roles of service providers in collaborating and the skill set for extension personnel to assist farmers with adoption a new activity -- production and post-production activities of off-season vegetables. Participatory action research has been effective in understanding and empowering community needs and societal problem solving in Pakistan (Aziz *et al*., 2011) and management of protected areas in Nepal (Fisher and Jackson, 1998).

This paper focuses on how the application of demand-driven, pluralistic participatory extension model played a role in delivering technological innovations (extension services) for socio-economic change and improved, sustainable livelihoods of rural people in Nepal. The MSU-initiated project focused on tomato production (off-season) using tunnel plastic houses (hoop houses) in the rural Nepal. The project hoped to facilitate increased production (farm productivity), income, and household consumption of fresh vegetables. It was believed that doing so would enhance food and nutrition security of participant farm households. There are possible next steps that include scaling up of both seasonal and off-season vegetable production as well as developing village-level agricultural extension workers (leader farmers).

METHODS AND APPROACH

Methodological Framework

Various methods and tools were part of the participatory research project including technical scientific observation, research, monitoring, and evaluation in different phases. The learning-based approach adopted provided opportunities for insights for dealing with complex situations and approaches for implementing projects in situations where people do not really know where to start or what to do next (Fisher and Jackson, 1998).

A baseline survey was conducted in 2013 to analyze the preliminary production environment and socio-economic aspects of farmer households in study area. At the end of the project, an endline survey using same survey instrument (from 2013) was implemented in 2015. The project and its data collection/analyses benefited from collaborative analysis and assessment which involved the participating rural communities, Indragufa Community Development Foundation (ICDF) staff, Michigan State University, Department of Agriculture (DOA), Nepal Agricultural Research Council (NARC), Agriculture and Forestry University (AFU) and other stakeholders. Technical support and oversight of the project elements were provided by MSU researchers. The project activities were conducted in various phases as described below.

Phase 1:

Plan: Investigate off-season vegetable production in the area and set up a pilot project.

Action: Preliminary situation analysis and assessment of agricultural production environment including a baseline survey with selected farmers. Implement a pilot project of plastic tunnel houses (about 92 tunnel houses). Tunnels were constructed and off-season tomato farming piloted with additional support. Farmers received vegetable production training and some of them were provided extra training in order to develop them as leader farmers (village-level agricultural extension workers).

Observation (Conclusion): The results of off-season tomato production in the first phase were promising. It appeared to be technically, economically and socially feasible /acceptable to incorporate plastic house, off-season vegetable production with farmers and their households in the study area.

Phase 2:

Plan: After observing the appealing results from the first phase (1st year), other farmers in the region voice their desire (i.e., demand) for access to support and guidance so they too could implement off-season vegetable production using plastic hoop houses. The MSU-team worked to scale up the program to reach an additional 200 farmers in the project's second year (2014).

Action: The project team in the research area promoted off-season tomato and increased numbers of participating farmers with project-team support built other vegetables and additional plastic tunnel houses.

Observation (Assessment): Harvesting and production of off-season tomatoes and other vegetables greatly increased. Farmers were positively motivated by the output of the previous year and many constructed additional tunnel houses on their own.

Phase 3:

Action: Off-season vegetable production technology was promoted and incentives were provided to encourage adoption. Leader farmers, in association with ICDF, MSU, DOA, NARC, AFU, NGOs and other stakeholders, help to provide agricultural extension services and inputs to their fellow farmers.

Observation (Assessment): Traditional / conventional farming of vegetables greatly reduced. Off-season vegetable production under plastic tunnel is increasingly adopted by participating and neighboring farmers (those who did not participate in the program). The income of farming households increased through the sale of fresh vegetables to local, regional markets, but the knowledge of post-harvest handling and processing of fresh vegetables seem to be inadequate, and a lack of storage facilities in the area hindered many farmers from benefits.

Phase 4:

Plan: Further scaling-up of vegetable production and post-harvest technology in the area is required. Effort to meet these demands is continuing.

Study Area

This project was undertaken in three villages in the Kaski district in western Nepal (Figure 1). The project villages (Hamsapur, Thumki and Rupakot) are located in the southeast part of the district, linked with a 25 km graveled road and a main roadway (Prithvi Highway) to Pokhara, the district headquarters. Although Kaski is a relatively well-developed district of Nepal with the nation's second largest city (Pokhara-Lekhnath Metropolitan), the study area is a rural environment in the foothills of the Annapurna range. Farm households with fertile land, forest resources, and subsistence farming are spread along the hillsides.

The study area has a unique climate, predominantly sub-tropical mid-hill zone ranging from subtropical to warm temperate with winter drought and summer rain. Mean annual rainfall is 3,979 mm, and mean annual temperature is about 20.9°C, with coldest month January (7°C) and hottest month May (30.5°C). The altitude varies from 600 to 1,200 m, with most of the area covered by sloppy hills with terraces, and practice subsistence agriculture, with average land holding of 0.54 ha (CBS, 2011). The project villages are inhabited by various ethnic groups, predominantly Brahmins, Chhetries, Gurung, Magars, Kami, and Sarki and covered in our sample.

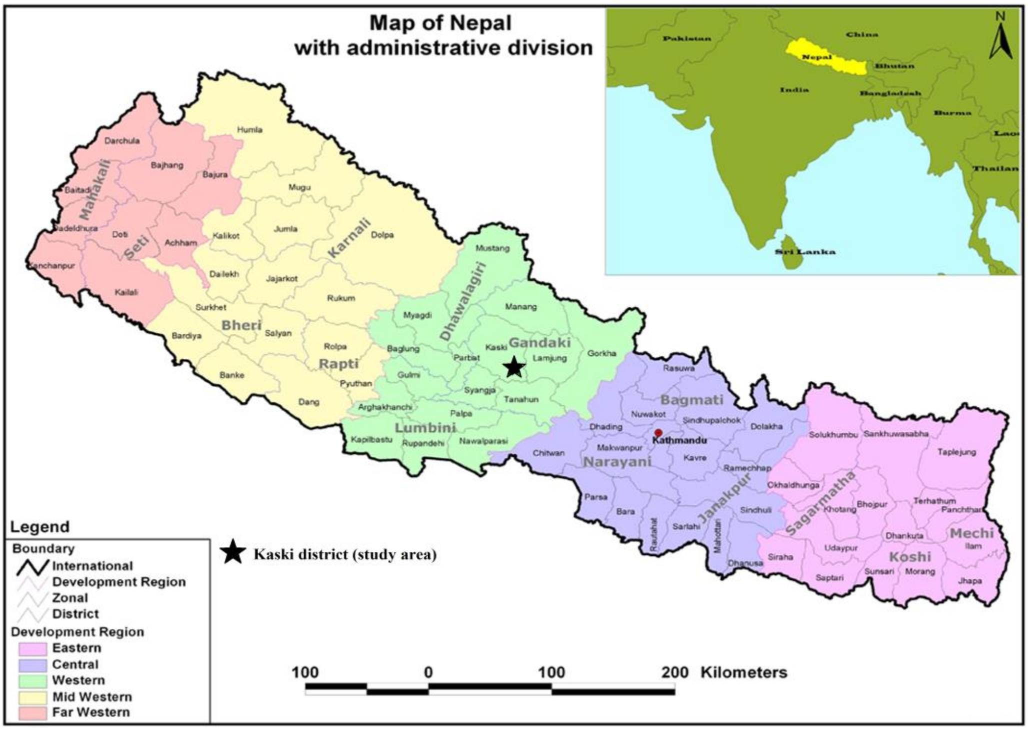

Fig. 1. Map of Nepal showing study area. (Source: MOAD, 2017 edited).

Data collection and sampling procedure

The study's population includes all farm households (mainly vegetable farmers) in the three villages. For this analysis, two surveys were conducted: a baseline survey during June-July 2013 and end-line survey was conducted during July–August 2015. Face to face, interviews of the farm household heads or principle decision maker were conducted to collect information on various aspects of household and farming systems. A multistage random sampling approach was employed in the selection of sample households. In the first stage, three villages, namely Hamsapur, Thumki and Rupakot were selected through purposive sampling. Accordingly, wards[1] 1 to 9 of Hamsapur VDC, wards 3, 5 of Thumki VDC, and ward 9 of Rupakot VDC were selected in the second stage. Finally, the total population of vegetable farmers in the area was identified from the list provided by VDC office, and then a random sample of 92 farmers for baseline survey (year 2013). For the end line survey (after the program intervention – year 2015), only 59 panel households were re-interviewed. The reasons for the loses of some observations (farm households) in the end line survey may include farmers leaving the villages for better employment opportunities elsewhere in Nepal as well as overseas employment as well as some potential respondents did not want to be interviewed.

Statistical analysis

Comparison of means (paired *t*-test) was used to estimate the impact of the project by comparing means of the responses to the same questions from the two surveys. The program impact

[1] A Ward is the lowest administrative unit at village level and all the administrative works are performed under the direct supervision of respective Village Development Committee office (VDC).

on the outcome being evaluated can be measured by the difference between the means of the samples of the two groups (before and after the program). The mean difference between the "after" and "before" values of the outcome indicators for each group was calculated and compared the treatment group 'before' and 'after' the project intervention. We used paired *t*-test because our two sets of measurements are dependent and correlated with each other, and under such conditions, the paired *t*–test gives more powerful and consistent results than a two-sample *t*–test (Hsu and Lachenbruch, 2007). Our null hypothesis was that the mean difference between paired observations is zero. When the mean difference is zero, the means of the two groups must also be equal. Because of the paired design of the data, the null hypothesis of a paired *t*–test is usually expressed in terms of the mean difference. The paired *t*–test assumes that the differences between pairs are normally distributed. We checked the normality of our data by using the histogram spreadsheet in STATA package. Some of the variables (data) were transformed in order to make sure that our data are normally distributed. The paired *t*-test is not very sensitive to deviations from normality, unless the deviation from normality is obvious.

Assumptions and variable specifications

Our assumption was that production outcomes would remain unchanged between 2013 and 2015 but for the program intervention. Although there have been exogenous changes over time period in such areas as weather, market infrastructure, information channels, and demand for vegetables, we assumed that both years (2013 and 2015) presented similar production environment, technology, and opportunities to participant farmers. This assumption is reasonable if climate conditions and the quality of other inputs such as land (e.g., soil quality), labor and machinery, are roughly the same over the period. As reported by MOAD (2014), general agricultural output for vegetables yield in Nepal during 2011 to 2014 was 13.40 tons/hectare, and in western region, it was 13.6 tons/ha. Because this trend remained similar from 2011 to 2014, we assumed that vegetables yield in 2015 will be roughly equivalent with the 2013/14 reported yields for the same area/region. This demonstrates that general equivalency in the market, environmental, and policy contexts for the research area's traditional vegetable production from 2013 to 2015.

Our project intervention focused mainly focused on using plastic tunnel houses for growing off-season vegetable production. In general, off-season vegetable production was non-existent in the region before the introduction of plastic tunnel houses. These structures allowed for vegetable production even if there was bad weather such as heavy rainfall, hailstorm, and drought, and the vegetables grew in the polyhouse remained unaffected. Kumar and Trumugam (2010) conducted a study under naturally ventilated polyhouse condition to test the suitability and influence of weather parameters on growth and yield of different vegetables including tomato in comparison with open field conditions. They reported that production and yield of vegetables were significantly increased in polyhouse over open field. Similarly, Sanwal *et al.* (2004) reported that protected controlled cultivation under tunnel house could solve the problem of low productivity during extreme weather conditions. Therefore, we expected that external factors such as weather condition that may, in fact, have differed between 2013 and 2015 not adversely affect the hoophouse production (yield) between the two years.

Regarding the outcome variables, we mainly focused on vegetable area (sq.ft.), production (kg), quantity sold (kg), income (NRs) and number of crops grown. The income variable includes only the cash income from vegetable sales. We did this because imputed value of vegetables consumed are mostly hypothetical and may lead to measurement error. To make income measures comparable, however, we changed the nominal income from vegetable sales into a real income measure by using price deflator with CPI 2010 as the base year.

RESULTS AND DISCUSSION

Descriptive statistics

Description of the study's demographic variables is presented in Table 1. In 2015, the mean age of household head was 47.79 years and 32 percent of the households were headed by female. More than two-thirds of the sample households were headed by males, which suggest the existence of some gender bias. The mean maximum years of formal education of the household head was 7.9 years and average household size was of 5.35 members. The average farm size (0.53 ha) is little lower than the national average land holdings of 0.7 ha in Nepal (CBS, 2011). More than half (59.32 %) of the households made farm decision by both (household head and spouse) where as 22% and 19% of the households made farm decision by male and female household head, respectively. About 55% of the respondents represented so-called high caste (Brahmin/Chhetri), 36% were janajati (middle-caste) and 10% represented dalit (lower caste or occupation-based caste).

Table 1. Description of demographic variables, means, percent and standard deviation (2015).

Variables	**Description**	**Mean (n=59)**	**Std. Dev.**
Age	Age of the HH head (years)	47.79	13.56
Education	Years of formal schooling of the HH's head	7.90	4.56
Household size	Number of family members	5.35	1.95
Farm size	Total cultivated area in the current year (hectare)	0.53	0.82
Dummy/ Categorical variables		*Frequency*	*Percent*
Gender of the Household head	Household head male = 1	40	67.80
	Household head male = 0	19	32.20
Farm decision	Farm decision made by male = 1	13	22.03
	Farm decision made by female = 2	11	18.64
	Farm decision made by both = 3	35	59.32
Ethnicity	Dalit (lower caste group) = 1	6	10.17
	Janajati (ethnic group) = 2	21	35.59
	Brahmin/Chhetri (so-called higher caste) = 3	32	54.24

Notes: n= Number of households, HH= Households.
Source: Field survey 2015.

Mean comparison test of paired data

Table 2 shows a paired *t*-test comparison of tomato production variables before and after the intervention. We included four variables in the hypothesis testing with the observed differences for the variables being significant. The mean area in production for tomato in 2013 was significantly lower than the mean area of tomato production in 2015 ($p<0.10$). Similarly, the differences for other variables such as production, quantity sold, and income (from tomato sale) were significantly different from 2013 to 2015 at the 1% level of significance. These results show that, after the project intervention, participating farmers were able to receive higher income from off-season tomato cultivation. We therefore reject our null hypothesis that the means of the tested variables in the 2013 data are not significantly different from those variables in the 2015 data. We therefore conclude that the program has positively impacted vegetable (tomato) production and household income.

Table 2. Paired *t*-test comparison of tomato outcome variables before and after intervention.

Variables	Tomato (n=59)[a]		Mean Diff. [B-A]	*t*-Stat
	2013 (Mean, SE) [A]	2015 (Mean, SE) [B]		
Area (sq.ft.)	342.08 (134.29)	598.08 (50.81)	256.01 (143.58)	1.78
Production (kg)	132.97 (40.23)	710.17 (69.93)	577.20 (80.67)	7.15*
Qty Sold (kg)	88.95 9 (31.27)	641.32 (125.69)	552.37 (129.53)	4.26*
Income (NRs)	4983.97 (1578.28)	13324.56 (1418.91)	8340.59 (2122.33)	3.93*

Source: Field survey 2013 and 2015.
Notes: * Significant at 1 % confidence level. Numbers in parentheses are the standard errors (SE). [a]n= number of observations. US$ 1 was equivalent to Nepali Rupees (NRs.) 102 during survey period (June-July, 2015)

Table 3 shows the differences between 2013 and 2015 data for other vegetables. The average production, quantity sold, and income appears to have substantially increased in 2015 while the area under cultivation just doubled. The change in mean area was statistically significant at the 10% level of significance while other three variables (production, quantity sold and income) were significantly different from the baseline data at the 1% level of significance. The mean income from vegetables increased substantially and was significantly different between 2013 and 2015. These results indicate that farmers started growing vegetables other than tomatoes and were able to increase their farm income. This would appear to help enhance food and nutrition security and the general livelihoods of rural farmers.

Table 3. Paired *t*-test comparison of other vegetables outcome variables before and after intervention.

Variables	Other vegetables (n=59)[b]		Mean Difference [B-A]	*t*-Stat
	2013 (Mean, SE) [A]	2015 (Mean, SE) [B]		
Area (sq.ft.)	1576.51 (517.01)	3070.05 (977.97)	1493.54 (785.77)	1.90
Production (kg)	219.03 (45.35)	1287.63 (225.52)	1068.59 (230.04)	4.65*
Qty Sold (kg)	128.44 (35.73)	889.17 (178.96)	760.73 (182.49)	4.17*
Income (NRs)	6021.71 (1555.47)	22654.81 (5064.86)	-16633.11 (5298.32)	3.14*
No. of vegetables grown	1.36 (0.19)	4.49 (0.29)	3.14 (0.35)	8.88*

Source: Field survey 2013 and 2015
Notes: * Significant at 1 % confidence level. Numbers in parentheses are the standard errors (SE).
[b]n= number of observations. US$ 1 was equivalent to Nepali Rupees (NRs.) 102 during survey period (June-July, 2015).

The average number of vegetable crops grown differs substantially for respondents between 2013 and 2015. For example, farmers who planted only two vegetable crops in 2013 grew about five types of vegetable crops in 2015. This difference was significant at the 1% level. Similarly, the income from vegetable crops was about 6,021 NRs. for the sample from 2013 and 22,654 NRs. for sample households in 2015. Volume of total vegetable production was significantly higher in 2015 as compared to the year 2013. The total area covered by vegetable crop appeared to be significantly different between two data; however, the level of significance was lower than other variables (10 % level of significance). The results from comparing mean differences between 'before' and 'after' the project indicate that farm households are better off in terms of area cultivated, production, marketed volume and income at the end year of the project. It should, however, be noted that mean difference comparisons may not take into consideration other characteristics of the farmers which may compound the impact of project on the farmer's wellbeing with the influence of other characteristics (Becerril and Abdulai, 2010; Kuhlgatz and Abdulai, 2011).

CONCLUSIONS AND RECOMMENDATIONS

A pilot action research project was commenced in Kaski district of Nepal in 2013 using the introduction of off-season production to demonstrate how service providers can collaborate and examine if extension services can assist farmers with production and post-production activities of off-season vegetables. The primary focus of this study was to test if the application of demand-driven, pluralistic extension model for delivering technological innovations (extension services) can promote socio-economic change and improve the livelihood of rural people sustainably. The off-season tomato production approach using tunnel plastic houses in the rural environment did increase participants' production (farm productivity), income, and consumption of fresh vegetables as well as to enhance food and nutritional security of farm households. The project is moving forward with efforts to scale up of both seasonal and off-season vegetable production as well as develop village-level agricultural extension workers (leader farmers). These leader farmers are expected to render agricultural information to the fellow farmers and sell agricultural inputs at reasonable price with small fee-for-service (entrepreneur-cum-extension workers) at the very grassroots levels.

We examined empirically the impact of the introduction of an agricultural technology (off-season vegetable production) on participants' household farm-based production and income. We analyzed and compared both baseline 2013 data (before the project) and endline 2015 (after the program) data. To evaluate the impact of the off-season vegetable production project, we compared the paired data taken at two points in time--before and after the project implementation -- assuming all else constant. Mean differences of the tested variables -- area, production, quantity sold, income and number crops grown -- appeared to be significantly higher when the project ended supporting the conclusion that the project supported farmers' increases in production, access to market, and farm income. Interestingly, farmers constructed additional tunnel houses on their own after seeing the increased outputs of the previous year. Off-season vegetable production under plastic tunnel is being adopted by participating and neighboring farmers (those who did not participated in the program).

The project developed leader farmers, in association with ICDF, MSU, DOA, NARC, AFU and other stakeholders, who provided agricultural extension services and inputs to the fellow farmers. This collaborative effort is notable and continues. The income of farming households in the project increased through the sale of fresh vegetables to local, regional markets, but the knowledge of post-harvest handling and processing of fresh vegetables seem to be inadequate, and there appears to be a lack of storage facilities in the area. Further scaling-up of vegetable production and post-harvest technology in the area is needed and welcome. It is hoped that there will be additional effort in those areas. The success of this project demonstrates the usefulness of a demand-driven, participatory agricultural extension model for Nepal Government extension officials, NGO professionals and donor community representatives interested in rapid dissemination of proven innovative extension strategies too hard to reach, small and marginal farmers. Widening access to information, extension services, inputs would provide producers with the means for investing in newer technology, thereby allowing for a full use of their managerial ability and for higher levels of output.

Finally, our work in these mountain villages of Nepal suggests that off-season vegetable production has strong potential for increasing household income and improving nutritional status/outcomes as opposed to the promotion of lower value, (traditional) staple crops. Getting timely and effective extension service support however remains a major challenge for such farmers. Farmers need to be empowered, not only economically, but also socially and intellectually to revive agricultural extension and sustain agricultural development. For this, adoption of bottom-up, demand-driven, pluralistic, cost recovery or fee-for-service, and participatory extension services are needed.

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