Journal of Agricultural Science; Vol. 9, No. 5; 2017
ISSN 1916-9752 E-ISSN 1916-9760
Published by Canadian Center of Science and Education

Assessment of Himalayan Nettle (*Girardinia diversifolia*) Value Chain Development Interventions: Evidences from Rural Households in the Far Western Nepal

Ghulam-Muhammad Shah[1], Manbar S. Khadka[2], Farid Ahmad[1], Nandakaji Budhathoki[3] & Anu Joshi Shrestha[1]

[1] International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal

[2] Asian Development Bank (ADB), Nepal Resident Mission, Kathmandu, Nepal

[3] Kathmandu Model Research Foundation (KMRF), Kathmandu, Nepal

Correspondence: Manbar S. Khadka, Asian Development Bank (ADB), Nepal Resident Mission, Kathmandu, Nepal. E-mail: skmanbar@gmail.com

Received: January 1, 2017 Accepted: March 7, 2017 Online Published: April 15, 2017

doi:10.5539/jas.v9n5p19 URL: https://doi.org/10.5539/jas.v9n5p19

Abstract

The Himalayan nettle (Note 1) is a fiber yielding non-timber forest product that has cultural, economic and medicinal values to many ethnic communities residing in the hill and mountain areas of Nepal and India. If the nettle value chain can be strengthened at each node of the chain, then it has high potentiality to uplifting the livelihoods of many poor households in those areas. With this objective, the Himalayan nettle value chain development interventions in the form of promotion of local institutions, enterprise development, product value addition and development, capacity building at the community level and promotion of linkages through private sector engagement were initiated in Darchula, one of the remote districts in far-western Nepal. This paper essentially analyzes the impact of Himalayan nettle value chain development interventions on households' income from the sale of nettle products. Using propensity score matching (PSM) technique in a cross-sectional data, this study finds that participation in the Himalayan nettle value chain development intervention has positive and significant impact on the households' annual income from the sale of nettle products. The participating households' annual income from the Himalayan nettle increases by NPR (Note 2) 2265-2410 than that of non-participating households with similar socio-economic characteristics. The study therefore argues that capacity building and facilitation activities on product development and market linkages are important to help increase productivity and decrease per unit production cost of non-timber forest products like the Himalayan nettle. Value chain development and concentrated market linkages are hence essential to diversify livelihood options for natural resource dependent rural communities.

Keywords: Himalayan nettle, value chain, impact evaluation, program intervention, propensity score matching

1. Introduction

The Himalayan nettle (*Girardinia diversifolia*) is popularly known as allo in Nepali. It is a fiber yielding non-timber forest and belongs to family *Urticaceae*. It grows from eastern to western region between the altitudes of 1,200 to 3,000 m (Friis, 1981; Shrestha & Hoshion, 1998). Fiber is present in the inner bark of the stalk with high strength and length. The fiber is considered superior to jute and is useful for mixing with wool and cotton. It has cultural, economic and medicinal values for many ethnic communities like Rai, Gurung, Sherpa and others living in the mountain areas of Nepal and India. The hilly residents and ethnic minorities have extracted the nettle bark for centuries to produce various items such as bags, porter's head bands or straps, ropes, mats and coarse clothing, among others. Different parts of the nettle plant are traditionally utilized as medicine. The Himalayan nettle products have both national and international markets values. In Nepal, people have tried to commercialize the fibre and develop high end products from apparels to home décor items. However, due to poor processing, packaging and standardization, its full potentiality is yet to be realized.

The Himalayan nettle is widely produced in Khar VDC (Village Development Committee) of Darchula district, one of the far-western remote districts in Nepal. Khar VDC alone accounts for 50 percent of the district's nettle production (ICIMOD, 2015). While Darchula is one of the most food insecure districts of Nepal with high level of poverty incidence (World Bank & CBS, 2011), it is rich in natural resources with various flora and fauna and non-timber forest products. If the nettle value chain can be strengthened at each node of the chain, then it has high potentiality to uplifting the livelihoods of many poor households in the district. This paper examines the impact of the Himalayan nettle value chain development intervention (in various forms such as promotion of local institutions and enterprise development, product value addition and development, capacity building at the community level and promotion of linkages through private sector engagement) on income from the sale of nettle products in 2015.

A value chain encompasses the full range of activities and services required to bring a product or service from its conception to sale in its final markets—whether local, national, regional, or global. The term 'value chain' refers to the fact that value is added to products and services as they pass from one link in the chain to the next through the combination with other resources, for example tools, human resources, knowledge, and skills, other raw materials or preliminary products (ILO, 2006). From the institutional perspective, a value chain can be defined as the organizational arrangements linking and coordinating the actors working at different points along the chain (Kaplinsky, 2004). Value chain development is regarded as a market-led approach as it helps satisfy the needs of the end consumers by fostering relationships and building trust among all stakeholders along a particular value chain to coordinate their activities. Various organizations have formulated approaches for value chain development. For instance, the International Centre for Integrated Mountain Development (ICIMOD) emphasizes inclusiveness, mountain specificities, and climate change perspectives (Hoermann et al., 2010), while aiming to overcome challenges and harness opportunities that can benefit the rural poor (Stamm & von Drachenfels, 2011). In addition to improved competitiveness and income distribution, which are core features of value chain development, the desired outcomes include higher income earnings for poor and vulnerable groups as well as active participation of women and youth (Altenburg, 2007).

Various types of value chain interventions such as trainings and better harvesting practices result in immediate benefits to the poor households in terms of increased income, enhanced understanding of environmental values and gender equality, among others. Such interventions further promote sustainable and quality production, thereby strengthening food security and fulfilling the basic necessities (Choudhary et al., 2011). Skill-enhancing training programs raise women empowerment in the form of increased income, more bargaining power and decision making on various fronts (Gurung et al., 2014).

Choudhary et al. (2014) show that that there are three folds increments in the market price due to rise in bargaining power. The increased bargaining power as a result of upgraded value chain leads to an increase in the households' income of bay leaf farmers in Nepal. Paudal et al. (2009) show that the use of improved technology is essential to increase the productivity and reduce per unit cost of production of the Himalayan nettle and Lokta (also known as Nepali paper) in the five VDCs of Baglung district in Nepal. The study further emphasizes on identifying constraints on value chain to make the Himalayan nettle and lokta (Nepali paper) production more profitable and competitive for sustainable development of rural livelihoods. Likewise, better market linkages help increase the households' earnings from non-timber forest products in Ethiopia (Gole & Koch, 2014).

Yet another study by Mahapatra et al. (2005) shows the importance of non-timber forest products in enhancing the rural livelihoods of the poor communities in Orissa and Jharkhand of India. The study finds that while the sale of non-timber forest products undoubtedly help enhance rural livelihoods, its impact however varies across ecological and socio-cultural settings. The study further argues that this variation should act as a basis as to where and when to apply non-timber forest product (NTFP) access and management policies (Mahapatra et al., 2005). Similarly, Meaton et al. (2015) apply value chain analysis to identify opportunities for the sustainable development of Ethiopian cardamom. Their study argues that the value chain development in the spice sector such as cardamom is essential and necessitates significant investment and expertise for its sustainable development (Meaton et al., 2015). Melaku et al. (2014) examine the relationship between non-timber forest products and household incomes in Bonga forest area of south-western Ethiopia. They find that non-timber forest products play a significant role in boosting households' incomes. In fact, the major non-timber forest products such as honey, coffee and spices accounted for 47 percent of the annual households' incomes (Melaku et al., 2014).

Using propensity score matching (PSM) method, Weber et al. (2011) show that program participation in forest-based microenterprises raises the household income level and capital accumulation of local residents of Amazon forest, Brazil. Cavatassi et al. (2011) examine whether or not linking smallholder potato farmers to high value agricultural market lead to significant changes in the household wellbeing in Ecuador. They find that there is positive and significant effect on participating households. Similarly, using PSM technique, Bonilla et al. (2011) assess the impact of seed capital program on the sales and employment of small businesses. They find that there is positive and significant effect on sales and number of workers of small and medium enterprises (SMEs).

Getachew et al. (2011) study the impact of market development programs on households' annual income in Ethiopia. They find that input and output market development programs have positive and significant impact on the adopter households' annual income (Getachew et al., 2011). In yet another study using PSM method, Budhathoki and Bhatta (2016) find that the adoption of improved rice varieties has positive and significant impact on the adopter households' annual agricultural earning and consumption expenditure in Nepal.

Nonetheless, a number of studies in Nepal that analyze the impact of program intervention on value chain analysis of various non-timber forest products are largely based on qualitative tools and techniques. Hence, this study intends to fill the research gap by applying propensity score matching technique to evaluate the impact of Himalayan nettle value chain development intervention on households' income from the sale of nettle products in Darchula district of Nepal.

2. The Himalayan Nettle Value Chain Intervention in Kailash Sacred Landscape

Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) is a trans-boundary collaborative programme among China, India and Nepal with a focus on conserving and developing natural resources. In Nepal, KSLCDI is jointly implemented by Ministry of Forests and Soil Conservation, Government of Nepal, Research Centre for Applied Science and Technology (RECAST), Tribhuvan University and ICIMOD in four districts of mid and far western regions of Nepal. The KSLCDI at ICIMOD has worked on capacity development of the communities, thus adding value to the Himalayan nettle products and improving market linkages. In fact, the program intervention was carried out from 2013 to 2015 in a recently established conservation area Api Nampa Conservation Area (ANCA). With a focus on promoting livelihood, the KSLCDI has adopted value chain development approach, whereby the Himalayan nettle was chosen for livelihood promotion of the rural communities. Intervention at various levels started from 2013 with the development of criteria to selection of value chain emphasizing on conservation and development. Various capacity building trainings at community levels were conducted. A number of enterprise development interventions that helped produce value added products such as bags, shawls, penholders, and other items were conducted at the local level. Several women leadership and mentoring programs, exposure visits and participation at trade fairs for marketing skills were conducted in 2015. In fact, KSLCDI has adopted a phase-in approach for this intervention. The first phase was initiated during 2014 after completing various scoping and assessment studies in 2013. During the first phase of the intervention, KSLCDI identified interested groups of people who would like to adopt the Himalayan nettle (also known as allo in Nepali) as innovative livelihood option. Following which, Bhumiraj allo association was registered as a processing center at Khar VDC of Darchula district with an objective to strengthen horizontal linkages so that the community will have better volume and higher bargaining power. The members of the association were mostly women as the nettle thread making, weaving, knitting and stitching are mostly done by women. Various capacity development activities throughout the year were organized in order to improve the quality of thread, develop new products and so forth. A common facility center with improved equipment and technology was provided to the association so as to increase efficiency as well as quality of products made out of the nettle. The assurance of market and the presence of private sector providing various trainings and exposure visits as well as offering buy back guarantee encouraged farmers to adopt new technology and accept the Himalayan nettle as an alternative livelihood option for them. Bhumiraj association started with 26 members and now has 76 members mainly from wards 1, 2, and 3. During the second phase, KSLCDI established Sundamunda allo association in 2015, comprising 35 members mainly from wards 7, 8 and 9 of Khar VDC of Darchula district.Thus far, KSLCDI has conducted preliminary capacity building related activities with this group.

3. Site and Data Description

Khar VDC (80.640171^{o}E, 29.794159^{o}N) of Darchula district is our pilot intervention site, while control households are randomly selected from nearby Yarkot VDC (80.690341^{o}E, 29.837993^{o}N) of the same district. The district is located at an altitude of 889 meters. It lies in the remote far-western region of Nepal and is bordered by India to the west and China to the north.

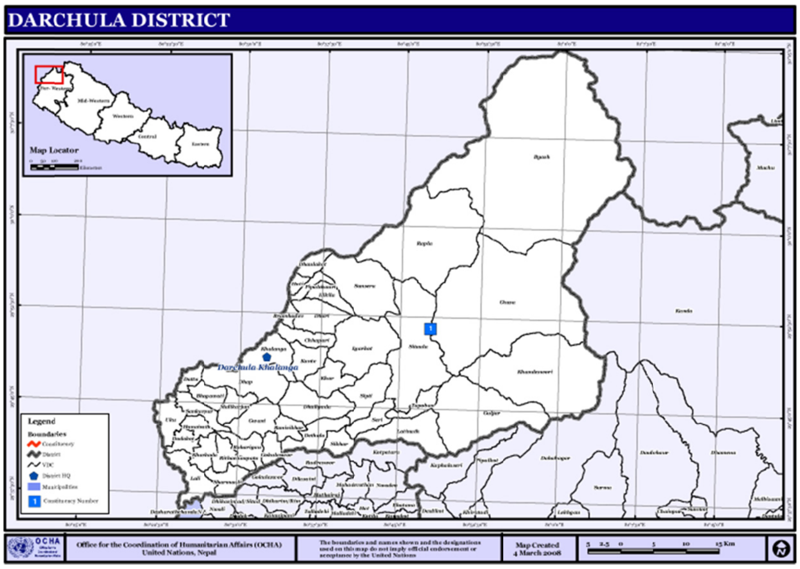


Figure 1. Map of Nepal depicting Darchula district

Source: Office for the Coordination of Humanitarian Affairs (OCHA), United Nations, Nepal (2008).

The top left corner shows the map of Nepal with the red triangle depicting Darchula district, and the central image is the map of Darchula district (Figure 1).

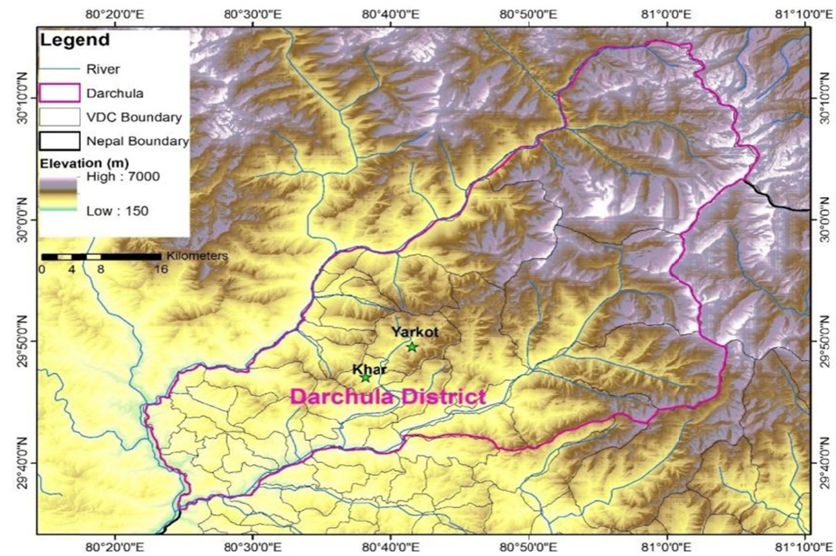


Figure 2. Map of the study area

Source: Geospatial Solutions Unit, ICIMOD.

A questionnaire was developed and administered to household heads or other responsible household members for data collection. A non-experimental survey design was adopted for this study. Using the household survey questionnaire, a rapid mid-term assessment of the Himalayan nettle value chain intervention was conducted and so information from randomly selected beneficiary households (*i.e.* members of Bhumiraj allo and Sundamunda allo associations) was collected. Information from another randomly selected 35 households was collected from ward 9 of the nearby Yarkot VDC, where the Himalayan nettle value chain development is not being implemented, but the households are traditionally involved in the nettle collection and production. It is assumed that these randomly selected 35 households will serve as control (non-beneficiary) households to our design. The baseline data basically captures information on household head's occupation and household's income; their involvement in agriculture and farming; the Himalayan nettle collection and production; Hemp (*Cannabis*) collection and production; Nigalo (*Drepanostachyum khasianum*) collection and production; Bamboo (*Poaceae*) collection and production; and livestock rearing. Like the nettle value chain beneficiary wards (1, 2, 3, 7, 8, and 9 in Khar VDC), the selected control ward 9 is the highest nettle producing ward in Yarkot VDC. Survey VDCs are marked with star as shown in Figure 2. Raw data was entered into excel and then imported into STATA for final data analysis.

4. Analytical Framework

The ideal scenario for impact evaluation is the Randomized Controlled Trial (RCT) which economists often call it the gold standard for evaluation due to randomly assigned interventions. Randomization implies that reasonable care is taken to ensure that every entity has an equal probability of being in either the treatment or control group (Becerril & Abdulai, 2010). But in the absence of non-randomness, where program participation becomes a self-selection issue, propensity score matching (PSM) is used in assessing the causal effect of program participation on the core outcome of interests (Wu et al., 2010). PSM compares the outcomes of treatment group with observationally similar nonparticipants (*i.e.* control group) to estimate the effects of the intervention (Heinrich et al., 2010).

The members of the associations so formed in Darchula under KSLCDI were provided trainings on the Himalayan nettle value chain development over the years. The site selection was not random and even the households that participate in the training programs were self-selected. For impact evaluation, the control households were randomly selected from nearby Yarkot VDC of Darchula district. These households are similar in socioeconomic characteristics to that of treatment households. Furthermore, they are equally involved in the Himalayan nettle collection, production and sale of nettle products, thus qualifying them as counterfactuals in this non-experimental survey design.

In order to compare the outcome of program participants with those of eligible non-participants from the control group, one needs to estimate the average treatment effect on the treated (ATT). More importantly, both the treatment and control households should be similar in terms of socio-economic characteristics. As shown in Heinrich et al. (2010), the average treatment effect on the treated (ATT) that captures the impact of the program on participating individuals is given by:

$$ATT = E\ (Y_1 - Y_0|D = 1) \tag{1}$$

Mathematically, ATT can be rewritten as:

$$ATT = E\ (Y_1|D = 1) - E\ (Y_0|D = 1) \tag{2}$$

The second term, $E\ (Y_0|D = 1)$ is the average outcome that the treated individuals would have obtained in the absence of treatment, which is unobservable.

But we do observe the average outcome for control individuals. Essentially, we can calculate:

$$\Delta = E\ (Y_1|D = 1) - E\ (Y_0|D = 0) \tag{3}$$

Adding and subtracting $E\ (Y_0|D = 1)$ in Equation (3), we have,

$\Delta = E\ (Y_1|D = 1) - E\ (Y_0|D = 1) + E\ (Y_0|D = 1) - E\ (Y_0|D = 0)$

$\Delta = ATT + E\ (Y_0|D = 1) - E\ (Y_0|D = 0)$ (from Equation (2))

$\Delta = ATT + SB$

Source: Heinrich et al. (2010). *A primer for applying propensity-score matching*. Inter-American Development Bank, Washington DC, USA.

The second term SB is the selection bias that basically captures the mean differences between the counterfactual for treated group (*i.e.* unobservable) and the observed outcome for the untreated group. If this term is zero, then there is no selection bias and so Equation (3) would give us an unbiased estimation of program impact. But given the nature of non-randomness in program placement, selection bias exists. And so, simply differentiating the mean outcomes between the treated and untreated groups will be a biased estimator of ATT (Wooldridge, 2010). For the correct estimation of the parameter, selection bias must be zero.

But in this study, the program intervention is a purposive one as reflected with program selection site as well as formation of Himalayan nettle (allo) associations. Had the program intervention been purely random, then the treatment status (D) would be uncorrelated with covariates (both observable and unobservable) and so the potential outcomes would be statistically independent of the treatment status (Heinrich et al., 2010). This is known as conditional independence assumption. In technical notation:

$$(Y_1,\ Y_0) \perp D \tag{4}$$

Where, Y_1 = outcome for treated group; Y_0 = outcome for control group; D = treatment status (1 for treated and 0 for control groups).

This basically hints that all the characteristics of the individuals are essentially similar between treated and untreated groups. So on an average, the mean characteristics between these two groups will be similar, meaning:

$$E\ (Y_0|D\ =\ 1)\ =\ E\ (Y_0|D\ =\ 0) \tag{5}$$

The Equation (5) implies that the expected outcomes for the treated individuals in the absence of treatment (unobservable) would be equal to that of untreated individuals (observable). So the left hand-side can be substituted with the right hand side to estimate the ATT in Equation (2). Hence, randomized experiments ensure that the bias term is zero and the program impact is simply the difference between the average outcomes between treated and untreated groups (Heinrich et al., 2010).

The second assumption that must uphold for unbiased estimation of ATT is the common support condition also known as overlap condition. This basically ensures that there is sufficient overlap in the characteristics of the treated and untreated units to find adequate matches' (Mendola, 2007). But PSM does not take into account any biasness emerging from time invariant unobserved heterogeneity. To overcome such biasness, PSM method can be employed first and then difference-in-difference model in a panel dataset (Bryson, 2002). For instance, using household-level fixed effect in panel dataset, Khadka (2009) analyzes the impact of availability of microfinance on child labor in rural Bangladesh.

5. Results and Discussion

Table 1 provides a summary statistics of key variables. The mean total income from the sale of Himalayan nettle products in 2015 for both treatment and control group is NPR 2422 (1 US$ = NPR 107). Interestingly, the mean total income from the sale of nettle products has been increasing over the years (Table 1). On an average, the households possess 6 bullock/cows. Nearly 88 percent of the survey respondents said that agriculture is their principal occupation.

Table 1. Summary statistics

Variables	Mean	Std. Dev.	Min	Max
Total income from the sale of Himalayan nettle in 2015	2422.2	12429.2	0	150000
Total income from the sale of Himalayan nettle in 2014	1467.1	8319.6	0	100000
Total income from the sale of Himalayan nettle in 2013	1331.6	6771	0	80000
Total number of bullock/cows	5.5	2.0	2	12
Household head respondent (Male = 1, female = 0)	0.3	0.4	0	1
Household head main earning (If agriculture then 1, else 0)	0.8	0.3	0	1
Agriculture land owned (Ropani)	11.2	6.3	1	40
Himalayan nettle bark extraction in 2015 (kg)	17.9	33.8	0	300
Himalayan nettle bark extraction in 2014 (kg)	14.8	29.1	0	200
Himalayan nettle bark extraction in 2013 (kg)	10.9	23.8	0	150
Total hemp income in 2015	457.1	1212.4	0	10000
Total nigalo income in 2015	1595.5	6593.5	0	65000
Total income from bullock/cows by-products in 2015	434.9	1324.3	0	7000
Total earnings from sale of crops in 2015	3177.2	8769.2	0	78000
Training in 2015 (Treatment = 1, control = 0)	0.7	0.4	0	1
Total number of observations (N)	146			

Note. the min. value for total income from the Himalayan nettle is zero because some of the households' production is not sufficient enough for sale.

The average land owned is approximately 11 ropanis (1 hectare = 19.65 ropani) per household (Table 1). The mean earnings from the sale of nigalo products are considerably higher than that of earnings from the sale of hemp in 2015. The mean earnings from the sale of various crops (wheat, maize, barley etc.) in 2015 is NPR 3,177. And nearly 75 percent of the respondents said that they received training on nettle value chain development in 2015.

Table 2. Mean comparison between the treatment and control households before matching

Variables	Mean (Control group) N = 37	Mean (Treatment group) N = 109	Mean difference
Agriculture land owned (Ropani)	6.7	12.7	-6.041***
The Himalayan nettle bark extraction in 2015 (kg)	37.9	11.1	26.836***
The Himalayan nettle bark extraction in 2014(kg)	32.2	8.9	23.321***
The Himalayan nettle bark extraction in 2013(kg)	30.0	4.5	25.477***
Total nigalo income in 2015 (NPR)	1945.9	1476.6	469.340
Total earnings from sale of crops in 2015 (NPR)	7334.4	1766.0	5568.404***
Total Himalayan nettle income in 2015 (NPR)	2047.5	2549.4	-501.882
Total Himalayan nettle income in 2014 (NPR)	1380.6	1496.4	-115.792
Total Himalayan nettle income in 2013 (NPR)	1322.9	1334.5	-11.614
Household head main earning (If agriculture then 1, else 0)	0.8	0.8	0.020
Household head main occupation (If farming on owned land then 1, else 0)	0.8	0.8	-0.007
Household head respondent (Male = 1, female = 0)	0.9	0.2	0.708***
Total hemp income in 2015 (NPR)	1476.7	111.0	1365.748***
Total livestock expenses in 2015 (NPR)	9443.2	2037.6	7405.629***

Note. *** denotes that mean differences between treatment and control households are statistically significant at 1 percentage level.

There are statistically significant differences in a number of observable covariates between the treatment and control households. The average landholding for treatment households is higher than that for control households and the difference is statistically significant at 1 percent level (Table 2). On the other hand, mean nettle bark extraction in all the years is significantly higher for control households than that for treatment households ($p < 0.01$). Likewise, mean earnings from sale of various crops (wheat, maize, barley etc.) in 2015 for control households are significantly higher than treatment households ($p < 0.01$) (Table 2). The mean earnings from the sale of hemp products is significantly higher for control households than that for treatment households ($p < 0.01$) (Table 2). And the control households spent significantly higher on livestock than treatment group in 2015.

A Logit model is used to predict the probability of household's participation in Himalayan nettle value chain development training. Table 3 reports the associated logit estimates. Findings show that gender of the household head, agricultural land holding and total livestock expenses in 2015 are important variables that determine household's propensity to participate in the training program.

Table 3. Results of Logit estimation of propensity scores

Variables	Coefficient	Z-value
Total income from the sale of Himalayan nettle in 2014 (NPR)	.0003	0.80
Total income from the sale of Himalayan nettle in 2013 (NPR)	-.0002	-0.39
Household head respondent (Male = 1, female = 0)	-2.4	-2.12**
Agriculture land owned (Ropani)	.29	2.61***
Himalayan nettle bark extraction in 2015 (kg)	-.06	-1.60
Himalayan nettle bark extraction in 2014(kg)	.02	0.81
Himalayan nettle bark extraction in 2013(kg)	-.01	-0.31
Total hemp income in 2015 (NPR)	-.0002	-0.65
Total nigalo income in 2015 (NPR)	-.00004	-0.51
Total earnings from bullock/cows by-products in 2015 (NPR)	-.0003	-1.35
Total livestock expenses in 2015 (NPR)	-.0001	-2.64***
Total earnings from sale of crops in 2015 (NPR)	-.00004	-0.66
Constant	1.84	-1.35
Number of observations(N)	146	
Pseudo R^2	0.70	

Note. ** and *** denote significance at 5 and 1 percent levels respectively.

Explanatory variables include total income from the sale of nettle products in 2014, total income from the sale of nettle products in 2013, a dummy variable representing gender of the household head, agriculture landholding, total earnings from the sale of various crops in 2015 and total livestock expenses in 2015, among others. The pseudo-R^2 of the Logit model estimate is 0.70 and the combination of variables satisfies the balance requirement.

Results show that female household heads have a higher probability of participating in the training program. With male household heads, there is a significant negative effect on propensity to participate in the Himalayan nettle value chain development training program. This is consistent with the general findings that more females than males are involved in collection, processing and marketing of nettle products in Darchula district. Households with more agricultural land area are more likely to participate in Himalayan nettle value chain development training program. And total livestock expenses in 2015 have a negative effect on propensity to participate in the nettle value chain development training program. This may be because higher livestock expenses are directly associated with number of livestock. Households with more livestock tend to spend significant time rearing their cattle and have less time for the nettle collection, processing and marketing activities.

5.1 Effect of Different Matching Algorithms

With the use of propensity score matching, we obtain the average treatment effect on the treated (ATT) as well as matched treated and non-treated observations. There are several matching techniques to estimate the effect of program participation (*i.e.* training) on households' total income from the sale of nettle products in 2015. The most widely used matching algorithms are the nearest neighborhood matching (NNM) and kernel-based matching (KBM). The NNM technique chooses matching partners (households) from the treatment and control groups that are closer with each other in terms of propensity scores. On the other hand, KBM is non parametric method that uses the weighted average of the outcome variable for all individuals in the control group to construct the counterfactual outcome. The weighted average is compared with the outcome for the treatment group. The difference estimates the impact of treatment on treated (Heinrich et al., 2010). Caliper matching approach is also employed in this paper. Caliper matching basically throws out the treated units that do not have 'good' matches.

Table 4. Effect of training on households' total income from the Himalayan nettle in 2015: matching estimates

Matching algorithms	Average treatment effect on treated (ATT)	Common support imposed	Balancing property satisfied
Nearest neighborhood matching (1) using one nearest neighbor	2265 (1.67)*	Yes	Yes
Nearest neighborhood matching (2) using two nearest neighbors	2329 (1.72)*	Yes	Yes
Nearest neighborhood matching (4) using four nearest neighbors	2409 (1.79)*	Yes	Yes
Caliper = 0.25	2265 (1.67)*	Yes	Yes
Kernel based matching	2345 (1.09)*	Yes	Yes

Note. z-statistics are in parentheses. * denotes significance at 10 percent level.

Matching estimates show that participation in the Himalayan nettle value chain development training programs has a positive and significant impact on household's total income from the sale of nettle products in 2015. NNM (1) uses one nearest neighbor from the control group that is closest with the household in the treatment group in terms of propensity score. On the other hand, NNM (4) uses four nearest neighbors for matching purposes. Caliper (0.25) matching restricts Pscore matches to be within 0.25 and so throws out the treated units that do not have a control case within the range of the caliper. NNM (1) and KBM show that participating households earn more than non-participating households from the sale of nettle products by NPR 2,265 per annum and NPR 2,345 per annum respectively (Table 4). In sum, the participating households' annual incomes from the sale of Himalayan nettle products increases by NPR 2265-2410 than that of non-participating households with similar socio-economic characteristics. Findings are consistent with all the matching algorithms.

Table 5. Mean values for treatment and control groups after matching

Variable	Mean		% bias	t-test	
	Treatment	Control		t	P > |t|
Agriculture land owned (Ropani)	12.77	12.31	8.7	0.61	0.54
Himalayan nettle bark extraction in 2015 (kg)	11.11	1.85	26.7	3.27	0.001
Himalayan nettle bark extraction in 2014 (kg)	8.92	1.16	25.8	3.26	0.001
Himalayan nettle bark extraction in 2013 (kg)	4.53	1.2	13	2.16	0.032
Total nigalo income in 2015 (NPR)	1477	110	23	1.96	0.051
Total earnings from bullock/cows by-products in 2015 (NPR)	115	1202	-71.2	-9.01	0.000
Household head respondent (Male = 1, female = 0)	0.21	0.63	-120	-6.94	0.000
Household head main earning (If agriculture then 1, else 0)	0.87	0.39	146.5	8.37	0.000
Total earnings from sale of crops in 2015 (NPR)	1766	428	17.1	1.51	0.133
Total hemp income in 2015 (NPR)	111	90	1.5	0.32	0.746
Total income from the sale of Himalayan nettle in 2014 (NPR)	1497	78	20.6	1.54	0.124
Total income from the sale of Himalayan nettle in 2013 (NPR)	1335	69	22.4	1.7	0.091
Sample	Pseudo R-squared		Mean bias for observed variables		
Unmatched	0.632		75.7		
Matched	0.524		34.6		

Mean standardized biasness among covariates has been significantly reduced after matching. The mean bias for observed covariates dropped from 75.7 to 34.6 (Table 5). Furthermore, we check whether the balancing property has been satisfied or not.

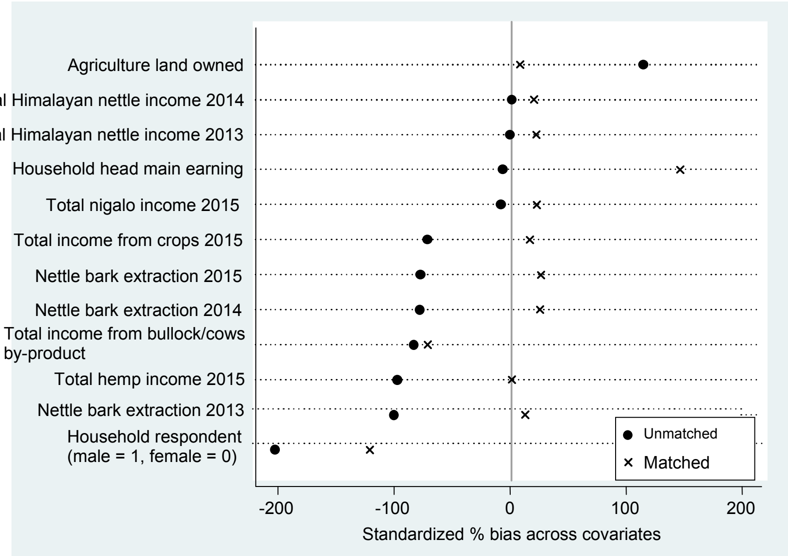


Figure 3. Checking for balanced match

Figure 3 shows that covariates are balanced across treated and non-treated groups in sample matched or weighted by propensity score. In essence, there is less biasness in the various covariates after matching between them. This also suggests that there is sufficient overlapping in the propensity scores of the treated and non-treated groups/households before matching.

Figure 4 presents the distribution of the propensity scores as well as the region of common support for both treated and non-treated groups. The idea is to see if we have enough overlap between the treated and non-treated groups to make reasonable comparisons. Looking at the graph, one finds that almost all the treated cases have propensity scores in the range of 0.8 to 0.9, and there seem to be few non-treated cases in that range (Figure 4). There are non-treated cases everywhere, but most of them appear to be concentrated in the range of 0.01 to 0.2.

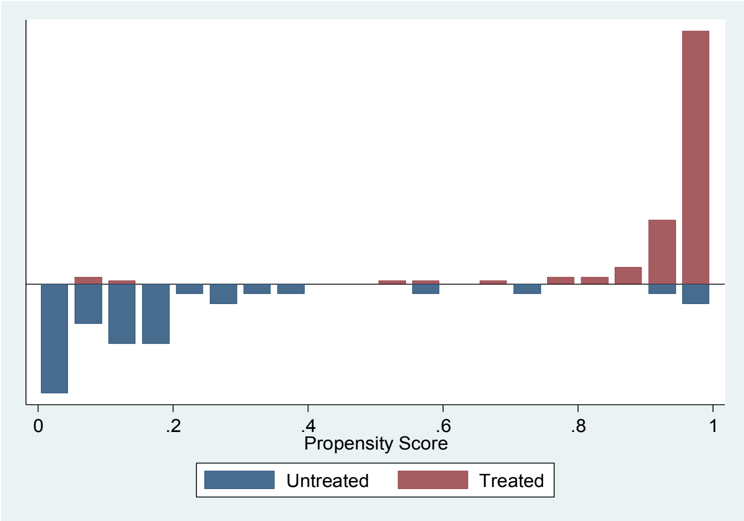


Figure 4. Checking for common support

There is a clear biasness in the distribution of the propensity scores between the treated and non-treated groups. Therefore, proper matching is essential and the common support condition will remove the bad matches. Hence to further examine whether common support property is imposed or not, we plot a histogram of the non-treated cases with propensity scores greater than 0.1 to better see the frequencies at the top end (Figure 5).

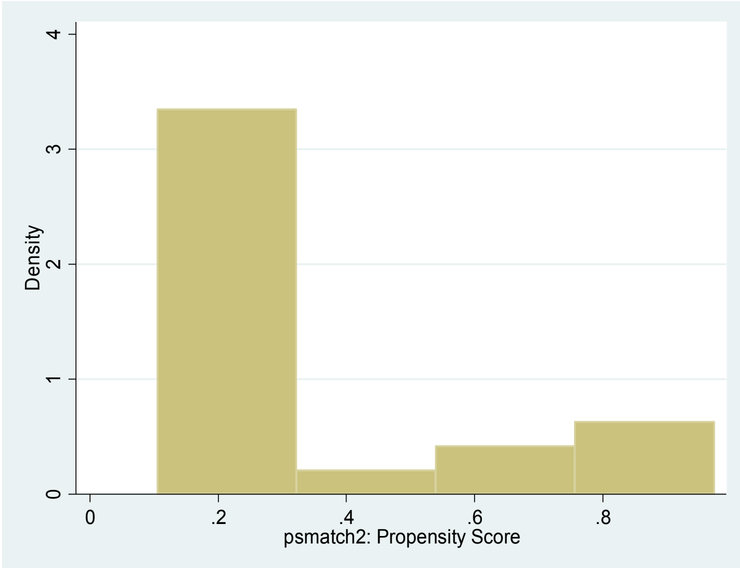


Figure 5. Common support property whether imposed or not

Figure 5 clearly depicts that there are non-treated cases that span the full range of propensity scores, but not many of them. Since we are doing matching with replacement, few non-treated cases with high propensity scores are used multiple times as matches to treated cases.

6. Conclusion and Way Forward

Using PSM technique, this paper examines the impact of the Himalayan nettle value chain program participation on households' income from the sale of nettle products in 2015. In the absence of randomization of the program, mere investigating the differences between the mean outcomes of treated individuals with that of non-treated individuals will yield biased estimation. Since PSM addresses biasness based on observable characteristics, it offers robust and reliable impact evaluation estimates.

In sum, this paper finds that program participation has positive and significant impact on the households' annual income from the sale of Himalayan nettle products. The participating households' annual incomes from the sale of Himalayan nettle products increases by NPR 2265-2410 than that of non-participating households with similar socio-economic characteristics. The study therefore argues that training on product development and market linkages are important to help increase productivity and decrease per unit cost of production of non-timber forest products like the Himalayan nettle. As such, District Development Committee (DDC) and Api Nampa Conservation Area (ANCA) need to promote Himalayan nettle and invest in the promotion of such non timber forest products. High quality end products made of Himalayan nettle are exportable and so the local government should facilitate mechanisms for the nettle collection, transportation and processing eliminating a lengthy procedure of getting collection permit. In essence, value chain development and market linkages are of utmost importance to diversify alternative livelihood options for natural resource dependent rural poor, thereby increasing their income from sustainable harvesting of non-timber forest products.

Acknowledgements

We would like to acknowledge Tariq Ahmad and Prabesh Devkota for their valuable contribution during pilot testing of household survey tool, translation of tool into Nepali language, data collection, and data entry. This study was undertaken under component one of the Kailash Sacred Landscape Conservation and Development Initiative (KSLCDI) of the International Centre for Integrated Mountain Development (ICIMOD), which is being implemented in India, Nepal and China. The KSLCDI is financed by Department for International Development (DFID)-UK Aid and Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung/ Deutsche Gesellschaft fủr Internationale Zusammenarbeit (GIZ) GmbH. We gratefully acknowledge the support of DFID and GIZ. Finally, we would like to thank the anonymous reviewers and the editor of this journal for their valuable comments and suggestions.

Disclaimer

The views expressed in this paper are those of the authors and do not necessarily reflect the views and policies of the ADB, ICIMOD and KMRF. Any errors are solely of the authors and the organizations that the authors are affiliated with cannot be held responsible for any inaccuracies and/or errors.

References

Altenburg, T. (2007). *Donor approaches to supporting pro-poor value chains. Report prepared for the Donor Committee for Enterprise Development Working Group on Linkages and Value Chains*. German Development Institute. Retrieved from http://www.fao-ilo.org/fileadmin/user_upload/fao_ilo/pdf/DonorApproachestoPro-PoorValueChains.pdf

Becerril, J., & Abdulai A. (2010). The impact of improved maize varieties on poverty in Mexico: A propensity score matching approach. *World Development, 38*(7), 1024-1035. https://doi.org/10.1016/j.worlddev.2009.11.017

Bonilla, C. A., & Cancino, C. A. (2011). The impact of the seed capital program of SERCOTEC in Chile. *Working Paper Series, 279*. Inter-American Development Bank.

Bryson, A., Dorsett, R., & Purdon, S. (2002). The Use of Propensity Score Matching in the Evaluation of Active Labor Market Policies. *Working Paper Number 4*. Policy Studies Institute and National Centre for Social Research, Department Work and Pensions on behalf of the Controller of Her Majesty's Stationary Office, UK.

Budhathoki, N., & Bhatta, G. D. (2016). Adoption of improved rice varieties in Nepal: Impact on household wellbeing. *Agriculture Research, 5*(4), 420-432. https://doi.org/10.1007/s40003-016-0220-z

Cavatassi, R., González-Flores, M., Winters, P., Andrade-Piedra, J., Espinosa, P., & Thiele, G. (2011). Linking smallholders to the new agricultural economy: The case of the plataformas de concertación in Ecuador. *Journal of Development Studies, 47*(10), 1545-1573. https://doi.org/10.1080/00220388.2010.536221

Choudhary, D., Pandit, B. H., Kala, S. P., Todaria, N. P., Dasgupta, S., & Kollmair, M. (2014). Upgrading Bay Leaf Farmers in Value Chains—Strategies for Improving Livelihoods and Poverty Reduction from Udayapur District of Nepal. *Society & Natural Resources, 27*(10), 1057-1073. https://doi.org/10.1080/08941920.2014.928392

Choudhary, D., Pandit, B. H., Kinhal, G., & Kollmair, M. (2011). *Pro-poor value chain development for high value products in mountain regions: Indian Bay Leaf*. International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal.

Friis, I. (1981). A Synopsis of Girardinia (Urticaceae). *Kew Bulletin, 36*, 143-157. https://doi.org/10.2307/4119014

Gelo, D., & Koch, S. F. (2014). The impact of common property right forestry: Evidence from Ethiopian villages. *World Development, 64*, 395-406. https://doi.org/10.1016/j.worlddev.2014.06.020

Getachew, Y., Jaleta, M., & Gebremedihin, B. (2011). Impact of input and output market development interventions on input use and net income of households in Ethiopia. *Journal of Economics and Sustainable Development, 2*(9), 22-33.

Government of Nepal, Ministry of Forests and Soil Conservation. (2014). *Value Chain Designing of Allo of Panchase Protected Forest Area*. Kathmandu, Nepal.

Gurung, M. B., Partap, U., & Choudhary, D. (2015). Empowering mountain women through community-based high value product value chain promotion in Nepal. *International Journal of Agricultural Resources, Governance and Ecology, 11*(3-4), 330-345.

Heinrich, C., Maffioli, A., & Vazquez, G. (2010). *A primer for applying propensity-score matching*. Inter-AmericanDevelopment Bank, Washington DC, USA.

Hoermann, B., Choudhary, D., Choudhury, D., & Kollmair, M. (2010). *Integrated value chain development as a tool for poverty alleviation in rural mountain areas: An analytical and strategic framework*. Kathmandu: ICIMOD.

ICIMOD. (2015). *Sustainable Livelihoods in the Kailash Sacred Landscape: Promotion of the Allo (Himalayan Nettle) Value Chain in Nepal*. Kathmandu, Nepal.

ILO. (2006). *An ILO guide for value chain analysis and upgrading*. Geneva.

Kaplinsky, R. (2004). Spreading the gains from globalization: What can be learnt from value-chain analysis. *Problems of Economic Transition, 47*(2), 74-115.

Khadka, M. S. (2009). The *Relationship between Child Labor and Microfinance: Evidence from Rural Bangladesh*. Maryland, USA: University of Maryland Theses and Dissertations. Retrieved from http://hdl.handle.net/1903/9660

Mahapatra, A. K., Albers, H. J., & Robinson, E. J. Z. (2005). The impact of NTFP sales on rural household's cash income in India's dry deciduous forest. *Environmental Management, 35*(3), 258-265. https://doi.org/10.1007/s00267-003-8203-9

Meaton, J., Abebe, B., & Wood, A. P. (2015). Forest Spice Development: the Use of Value Chain Analysis to Identify Opportunities for the Sustainable Development of Ethiopian Cardamom (Korerima). *Sustainable Development, 23*, 1-15. https://doi.org/10.1002/sd.1563

Melaku, E., Ewnetu, Z., & Teketay, D. (2014). Non-timber forest products and household incomes in Bonga forest area, southwestern Ethiopia. *Journal of Forestry Research, 25*(1), 215-223. https://doi.org/10.1007/s11676-014-0447-0

Mendola, M. (2007). Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. *Food Policy, 32*(3), 372-393. https://doi.org/10.1016/j.foodpol.2006.07.003

Paudel, A., Subedi, B. P., Gyawali, S., Thapa, G. K., & Sharma, M. B. (2009). Value chain analysis of non-timber forest products in Baglung district, Nepal. *Banko Janakari, 19*(2), 33-41.

Rai, J. K., & Chapagain, S. P. (Eds.). (2014). *Value Chain Analysis of Forest Products in Koshi Hill Districts of Nepal: Challenges and Opportunities for Economic Growth*. Forest Action Nepal and RRN, Kathmandu.

Shrestha, R., & Hoshion, T. (1998). Karyomorphological studies in Girardinia diversifolia (Link) Friis (Urticaceae) collected from Nepal. *Journal of Japanese Botany, 73*(3), 125-127.

Stamm, A., & von Drachenfels, C. (2011). *Value Chain Development: Approaches and Activities by seven UN Agencies and Opportunities for Interagency Cooperation*. ILO, Geneva.

Weber, J. G., Sills, E. O., Bauch, S., & Pattanayak, S. K. (2011). Do ICDPs work? An empirical evaluation of forest-based microenterprises in the Brazilian Amazon. *Land Economics, 87*(4), 661-681. https://doi.org/10.3368/le.87.4.661

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. The MIT Press, Cambridge, Massachusetts London, England.

World Bank, & CBS, Nepal. (2011). *Nepal Poverty Map 2011 for all districts*. Indicator: Percentage of Poor. Retrieved from http://dataviz.worldbank.org/t/SASEP/views/NepalTargetLevelFinal/NepalPovertyMap2011?:embed=y&:display_count=no

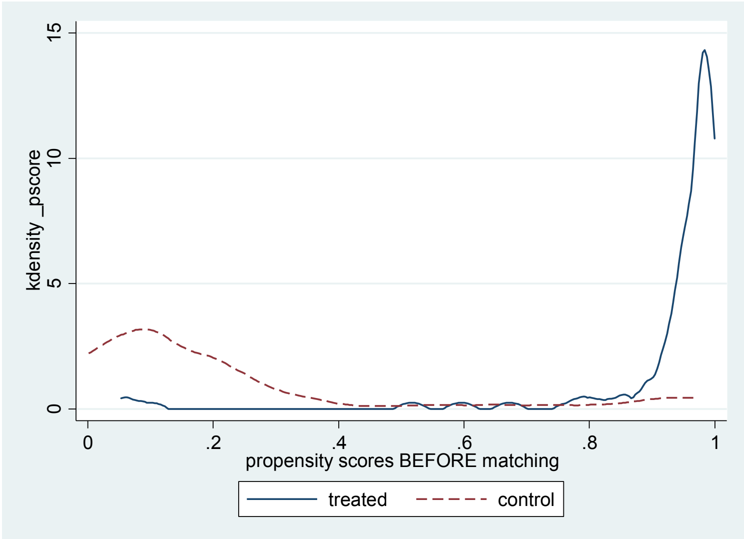
Wu, H., Ding, S., Pandey, S., & Tao, D. (2010). Assessing the impact of agricultural technology adoption on farmers' well-being using propensity-score matching analysis in rural China. *Asian Economic Journal, 24*(2), 141-160. https://doi.org/10.1111/j.1467-8381.2010.02033.x

Notes

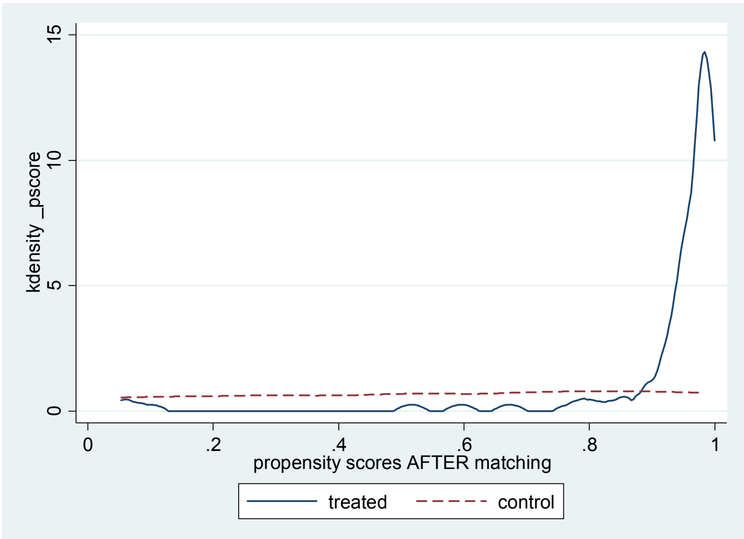
Note 1. The Himalayan nettle and nettle are interchangeably used throughout the paper.

Note 2. 1 US$ = NPR 107.

Appendix



Appendix A. Propensity scores of treated and control variables before matching



Appendix B. Propensity scores of treated and control variables after matching