Promoting Rural Livelihoods through Riverbed Vegetable Farming in the Tarai Region of Nepal

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Abstract

Agriculture supports the livelihoods for more than 65% of the Nepalese, and also serves as the mainstay of the rural economy. In recent years, climate change has induced direct impacts on natural and human systems altering productivity, biodiversity and functions of many ecosystems and livelihoods. The agriculture sector is adversely affected by climate change, and the rural poor are becoming more vulnerable to unsustainable livelihoods. Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) in partnership with Plan Nepal tested the technology of riverbed vegetable farming and it has been scaling out this technology in Tarai areas of Nepal. Riverbed farming is a pro-poor focused program for the rural community. Altogether, 333 participating farmers were organized into 17 groups for riverbed vegetable farming in Morang and Banke districts. Farmers grew cucurbit species on riverbed areas. Three years' average vegetable crop yields recorded in Banke and Morang districts were 12.6 t/ha and 25.6 t/ha, respectively. Farmers used to sell their produce in local *haat*, local market places and Indian markets. When net profit from group profile record was calculated, it was NRs. 10,029.0 and NRs. 7,697.0 per household per cropping cycle in Banke and Morang, respectively. Net profit per cropping cycle calculated from individual household from 2 *Kattha* (666) area was found

to be NRs. 15,026.0. The benefit:cost analysis of riverbed vegetable farming ranged between 1.4 and 4.8 when calculated for 20 farms. Among the vegetable crops grown by farmers, the highest benefit:cost ratio of 2.7 was found with bottle gourd. Incomes generated by riverbed vegetable growers were used primarily for meeting their household food security. More than 12% of landless families purchased land using the income from vegetables and became land owners. High nutrient requirements for crops, stray animals, strong windstorms, and long spell of droughts are major constraints to riverbed vegetable farming. Cultivation of vegetables on riverbed is easy in terms of land preparation, cultural practices and irrigation management. The profitability from riverbed farming is lower due to low productivity and high cost of production of vegetables compared to conventional farming. However, riverbed vegetable farming has been emerged as a niche based on-farm income generation activity fpr landless and land poor families and well accepted by farmers and agricultural organizations. As the area under riverbed is increasing every year, efforts in partnership with governmental and non-governmental sectors need to be concentrated for the benefit of landless and land poor families by utilizing wastelands.

Key words: Climate change, livelihoods, riverbed vegetable farming, landless and land poor farmers, producer group, leader farmers, cucurbit species, cropping cycle, market chain, benefit:cost analysis

1. Introduction

Agriculture is the basis of livelihoods for more than 65% of the Nepalese particularly for those living in the rural areas. It is the mainstay of the rural as well as national economy contributing 34% of the national gross domestic product (GDP) (World Bank, 2007). Over 50% of Nepalese live under absolute poverty having incomes less than $1.25 a day (Dhungel, 2009). The country has only 17 percent land area suitable for agriculture which comes to be about 2.5 million ha (FAO, 2007). Over the past few decades, there has been spiraling population growth making arable land limited for food production. The growth rate of cereal production at 1.2% over the past five years has remained frustratingly low and below the growth rate of the population (FAO, 2007). It has been estimated that if the current situation continues, 3.9 million people in rural Nepal would become food insecure, and 2.5 million people would need immediate assistance within two years (FAO, 2008). Agricultural production systems in rural areas is still dominated by subsistence farming, small holdings, low use of production inputs and degradation of natural resource base. There is now an immediate need to revitalize the farming system through the integration of modern technologies, best utilization of locally available resources and market-oriented production systems in a sustainable approach. For this, technology and innovation systems must go well beyond raising crop yields for increasing the overall farm productivity and profitability to meet the challenges of increasing resource scarcity in the changing socio-economic and climatic conditions.

The overwhelming global issue of climate change is more prominent in Nepal being a fragile mountainous country in South Asia with poor adaptive capacity of the people (GON, 2009). Erratic and unpredictable rainfall patterns, temperature extremes (both in summer and winter) and hot and cold waves have been experienced in recent years. As a consequence, landslides, soil erosion, flash floods, droughts and famine have been nation-wide issues and are in increasing trends (Dhungel, 2009; NAPA, 2010). Climate change has induced direct impacts on natural and human systems altering productivity, biodiversity and functions of many ecosystems and livelihoods. The agriculture sector is adversely affected by climate change and the rural poor are the most vulnerable groups to climate change impacts leading to unsustainable livelihoods (Rai, 2007; NAPA, 2010). In this context, development efforts that diversify livelihoods options based on local knowledge and resources, and that also enhance innovative capacity of people for better management of natural resources in the changing context are the dire need of the day for adaptation to climate change.

Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) Nepal has been empowering farming communities to adapt natural hazards resulted due to climate change. Heavy floods during the rainy season have converted a large area of lands as riverbeds and riverbanks in many parts of Tarai Nepal. It has not been reported exactly but there is significant areas of land in Nepal under riverbeds and flood affected, and the area is increasing every year. Thousands of families have been displaced from their farming profession to the landless situation, and in Tarai area 25% of the families are landless (Helvetas, 2010). Realizing the need of identifying appropriate farming technology against this extreme havoc of climatic disaster, FORWARD in partnership with Plan Nepal tested the production of vegetable crops on riverbeds as pilot in some Village Development Committees (VDCs) of Morang district since 1998. Upon the success of the technology in the piloting program, it was scaled out to Banke and other districts of Nepal. Now, this technology has been widely adopted and scaled out by different governmental and non-governmental institutions throughout the country. This paper presents findings and experiences of FORWARD Nepal with three years' data on riverbed vegetable farming in two districts of Nepal.

2. Program implementation and data management methodology

Riverbed vegetable farming is a pro-poor focused intervention for the rural community. The primary objective of this intervention is to raise household incomes of landless and land poor families[1] through employment generation at local level. The secondary objective is to improve the environment with green enterprise by utilizing wastelands. The landless and land poor families residing in the vicinity of rivers with the potential of riverbed farming were selected for the project interventions. Majority of them have large family size (5 to 8 members per family) aggravated by acute food and nutritional insecurity problem. They lack appropriate means of livelihoods and are compelled to depend on share cropping and wage laboring. They also go to different parts of India for seasonal wage laboring. While selecting the participants, preferences were given to families who lost their land by floods or riverbank erosion and those who were willing to participate in riverbed vegetable farming. Wherever, landless families did not have their own riverbed area, the land was rented in from other riverbed area owners and/or VDCs. The property right of riverbed land belonged to either individual farmer or VDC which is the local government. The rent for riverbed area was on average NRs. 300.0 per *Kattha* (333 m^2 area) per year. Selected farmers were organized into riverbed vegetable producer groups. The group size varied from 5 to 28 depending upon the number of interested farmers and the riverbed area available for vegetable farming in a particular block. The riverbed vegetable producer groups signed contract agreement either with the riverbed land owner or concerned VDCs for leasing in the riverbed area for one to three years. From the year 2007/08 to 2009/10, there were 10 groups in Morang and 7 groups in Banke for riverbed vegetable farming. Out of the total 333 participating farmers in two districts, 78.4% were men and 21.6% were women.

After the organization of participating members into groups, each group selected riverbed area in blocks for commercial vegetable production with the facilitation of the project. To the extent possible, riverbed area with fertile alluvial deposits were selected. All the groups were facilitated to prepare an action plan for the production and marketing of fresh vegetables. After preparing the group plan, one-day practical training on riverbed vegetable production was given to all producer groups. Arrangements were made for the provision of vegetable seeds, chemical fertilizers and plant protection materials to the producer groups on full subsidy basis in the first year. Subsidy on production inputs were gradually reduced to 75% and 50% with cost sharing by each participant in the second and third years, respectively. From the fourth year, no subsidy was provided, and participants continued to produce vegetables on their own. However, technical and managerial supports were provided from the project side through community mobilizers and field technicians. Producer groups conducted monthly meetings to discuss on their on-going activities, associated problems and find out possible solutions. They also generated fund by group saving which was mobilized as credit to the members for productive purposes.

A group profile format was developed to record data from all producer groups. Information from each group was collected in monthly meetings. Data on number of participants, area under riverbed farming, the total amount of vegetable production, household consumption, sales volume, sales values, cost of production and net profit was collected from each producer group. A total of 20 leader farmers from different producer groups were selected for the calculation of benefit:cost ratio of riverbed vegetable farming. Similarly, the cost of cultivation and incomes were recorded from leader farmers for calculation of the net profit.

3. Technology of riverbed vegetable production

The participants selected vegetable crops which could be sold in the local *haat* (temporary market) and nearby markets. Cucurbit species are suitable crops to be grown on riverbed areas. Crops selected and grown by farmers were water melon (*Citrullus lanatus* T.), cucumber (*Cucumis stivus* L.), bottlegourd (*Lagenaria siceraria* S.), summer squash (*Cucurbita pepo* L.), bitter gourd (*Momordica charantia* L.), pumpkin (*Cucurbita moschata* D.), pointed gourd (*Trichosanthes dioica* R.) and sponge gourd (*Luffa cylindrica* R.). Few farmers also grew tomato (*Lycopersicon esculentum* M.) on the riverbeds. The riverbed area selected consisted of silty soil (pure sand is not good) with water table of 0.60 m to 0.75 m below the land surface. The area under riverbed vegetable cultivation by participating farmers in Morang and Banke districts for three consecutive years was 41.0 ha and 57.6 ha, respectively. As there was no need of ploughing the riverbed area, participants prepared the land by digging pits of 0.65 m x 0.65 m size. Distance between row to row and plant to plant was maintained at 1.5 m to 2.0 m and 1.0 m, respectively. In each pit, farmers used 3-5 kg compost, 10 g urea, 25 g dia-ammonium phosphate (DAP), 15 g of muriate of potash and 2 g borax at the time of seeding. Compost and chemical fertilizers were well mixed with soil before seeding (Chapagain and Pandey, 2006).

Majority of farmers used to grow vegetable crops by direct sowing in the pits. Seed rate used was 300-350 g/ha for cucumber, 450-500 g/ha for bottle gourd and sponge gourd, and 1.5 kg/ha for water melon and bitter gourd. Cucurbit seeds were soaked in water for 24 hrs, floated seeds were removed and remaining seeds were air dried. Then seeds were wrapped in big sized green leaves, again wrapped by muslin clothes and it was put into compost heap for 3-4 days for germination. After germination, two

seeds were sown per pit. After sowing the seeds, mulching was done using locally available dry grasses. Sowing of seeds was done between November and December. However, early sown seeds showed better performance because of good emergence and early plant vigor before the extreme cold season. Some of the riverbed vegetable producer groups kept vegetable nursery under plastic tunnel sowing the seeds in soil and compost mixed poly pots. The plastic tunnel was managed by opening the plastic during the day time and closing it during the night time. Seedlings were transplanted in the pits starting from the second week of February.

As the plants started growing, farmers used 15 g urea per plant after 20-25 days of sowing and again 15 g urea per plant after 40-45 days after sowing as top dress. Early sown plants started flowering from the end of February. At the flowering stage, farmers used two sprays of Miraculan (plant hormone) at 10 day intervals to enhance flowering and fruiting. If the plants showed the deficiency of micronutrients, 1.0-1.5 ml multiplex per liter of water was sprayed on standing crops. Crops were infested by red pumpkin beetles, aphids, fruit flies which were controlled by hand picking of insects and spraying of cattle urine (1:5 urine to water ratio) as pest repellant. Root rot, powdery mildew and downy mildew were major diseases which were controlled by spraying appropriate fungicides (Chapagain and Pande, 2006).

Figure 1. Bottle gourd plants growing on the riverbed field

4. Harvesting, production and marketing of vegetables

Crops were ready for harvesting starting from March and lasted up to June. Vegetable crop yields were lower in Banke compared to Morang because crops in Banke were affected by severe drought and heat waves. Three years' average vegetable crop yields recorded in Banke and Morang districts were 12.6 t/ha and 25.6 t/ha, respectively. Early harvested crops had high market demand and fetched good prices as off-seasonal vegetables. The market price trend analysis showed that vegetables in March were sold at NRs. 20 to 25 per kg which later dropped to NRs. 8 to 12 per kg during May/June. There is weekly *haat* (temporary market) system at village level in the Tarai region. Therefore, *haats* take place everyday in the nearby villages and farmers have the advantage of this local market for selling fresh vegetable on regular basis. The participating farmers sold their vegetables in local *haats* which usually take place in the afternoon. Large number of participating women members were also involved in selling vegetables in local *haats*.

Figure 2. Water melon being harvested by the farmer

In the vegetable market chain, there were local traders who collected vegetables from *haats* and delivered to different end markets within and outside the district. Where the production sites were bordering to India, large quantities of vegetables were exported to Indian markets. Vegetables were put in different sized locally made bamboo baskets for marketing. Bicycles and other means of transportation such as bullock drawn carts, public buses and jeeps were used for vegetable transportation to market places. Farmers fetched a higer price (NRs. 2 to NRs. 5 per kg) of their produce from Indian markets compared to Nepalese markets if produced earlier. Some innovative farmers growing vegetables in larger area used to carry vegetables to nearby markets instead of selling to local traders in *haats*. In this regards, there is prospect of operating collective marketing system by riverbed vegetable producer groups linking into value chain with wholesalers in the big end markets. A typical fresh vegetable market chain followed by producers and other market actors is as follows:

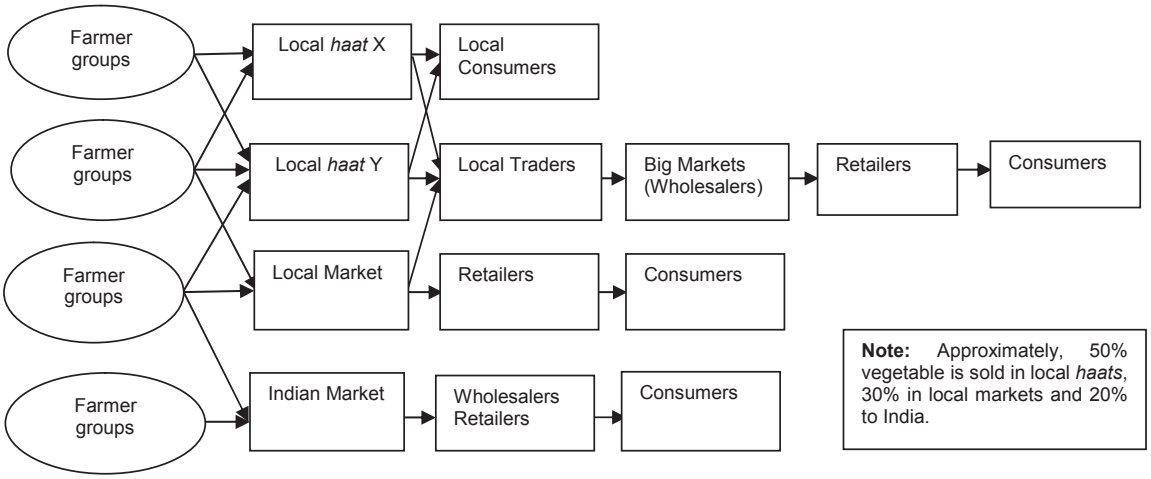

Figure 3. Market mapping of fresh vegetables produced by riverbed growers

5. Household incomes from riverbed vegetable farming

Vegetables produced by farmers on riverbeds were primarily sold for income generation and also consumed by their families. Out of the total amount (1778 tons) of vegetables produced by growers in three cropping cycles, 95% was sold in the market whereas 5% was consumed by their families. The average per household income from riverbed vegetable farming in one cropping cycle was found to be NRs. 21,454.5 and NRs. 21,930.2 in Banke and Morang, respectively. When net profit per household was calculated, it was NRs. 10,290.0 and NRs. 7,697.0 in Banke and Morang, respectively. The income per household per cropping cycle from riverbed vegetable farming varied with the area under vegetables. Farmers growing vegetables in larger area earned more compared to those growing in smaller areas. Even with low productivity, the higher net profit per household in Banke was because of larger area of riverbed farming per household, and selling vegetables in Indian markets at higher prices. Riverbed vegetable farming requires high level of inputs and thus the net profit is relatively lower than commercial vegetable production business by conventional farming in fertile lands. However, the leader farmers cultivating vegetables in more than 1320 m^2 (4 *Kattha*) riverbed area earned more than NRs. 40,000.0 per season. Helvetas Nepal (2010) also reported that farmers earned NRs. 28,800.0 to NRs. 43,200.0 in five months' period from riverbed vegetable farming in 1320 m^2 (4 *Kattha*) area. Some farmers exchanged fresh vegetables with food grains (paddy and wheat) with their neighbors which contributed for household food security. The area under riverbed vegetable farming, total volume of production, household consumption, sales volume and sales values for three consecutive years are presented in Table 1 below.

Table 1. Summary of area, production, consumption, sales volume, sales values and net profit of riverbed vegetable farming

District	Year	Area (ha)	Total members	Production and sales (tons)			Total Income (NRs. 000)	Prodn. Cost (NRs. 000)	Net Profit (NRs. 000)
				Consumed	Sales	Total			
Banke	2007/08	19.6	151	15	256.9	271.9	3082.9	1502.1	1580.8
Banke	2008/09	19.4	148	16.9	221.1	238.0	3095.4	1629.6	1465.8
Banke	2009/10	18.7	142	13.9	205.2	219.1	3283.3	1792.0	1491.3
Sub-total		**57.7**	**441**	**45.8**	**683.2**	**729.0**	**9461.6**	**4923.7**	**4537.9**
Morang	2007/08	12.1	182	15.2	292.1	307.3	2715.6	1074.9	1282.3
Morang	2008/09	15.2	182	14.1	376.1	390.2	4241.6	2106.2	1433.2
Morang	2009/10	13.7	175	13.6	337.9	351.5	4863.2	2572.4	1433.2
Sub-total		**41.0**	**539**	**42.9**	**1006.1**	**1049.0**	**11820.4**	**5753.5**	**4148.7**
Total		**98.7**	**980**	**88.7**	**1689.3**	**1778.0**	**21282.0**	**10677.2**	**8686.6**

The large part of income generated by riverbed vegetable growers were used for purchasing food grains to meet household food security. They spent part of their income for the treatment of the family members in case of illnesses, and for the education of thier children. They also gathered some assets like goats, cows and buffaloes from their income which further helped to improve the livelihoods of landless and land poor families. It is worth mentioning that more than 12% of landless families purchased land using the income from vegetables and became land owners. Previously, landless families were compelled to take loan from landlords at high interest rate (up to 36% per year) due to lack of cash money. Now, they do not need loan from landlords because they have income source from riverbed vegetable farming. The trend of riverbed vegetable growers going to India for seasonal wage laboring has also significantly reduced.

6. Benefit: cost analysis of riverbed vegetable farming

The benefit:cost ratio of riverbed vegetable farming ranged between 1.4 and 4.8 when calculated for 20 farms. Farmers had smaller benefit:cost ratio where crops were poor with low production of vegetables due to grazing by stray animals, damage of plants by strong windstorms and early water stress during March/April. The benefit:cost ratio also varied with types of vegetable crops grown because farmers grew different combinations of vegetables in their farm. All participating farmers grew at least three crops to minimize risk of production and market failures. Majority of farmers grew bottle gourd, water melon and cucumber in combination and the benefit:cost analysis of these crops done separately is shown in the figure below.

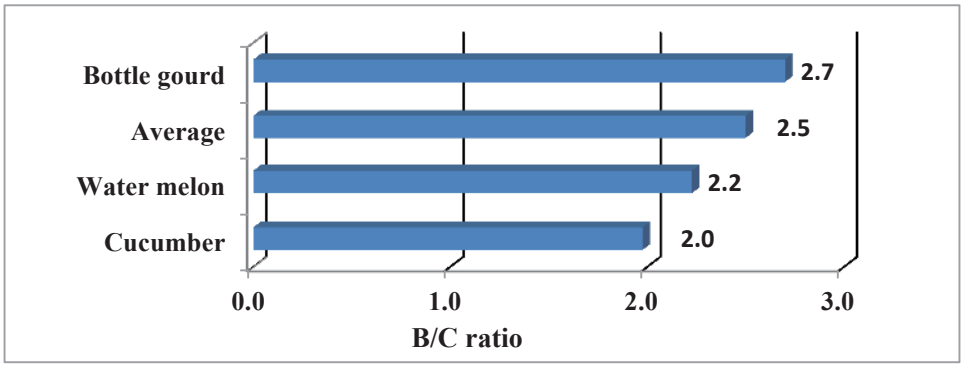

Figure 4. Benefit:cost ratio of vegetable production in riverbed farming

Figure 4 shows that bottle gourd is the most profitable vegetable crop for the riverbed farmers. If all farmers grow bottle gourd, it is expected that there will be market glutting and demand as well as prices will go down. This will increase the risk of market failure and result into low profitability from vegetable farming. Therefore, a combination of 3 to 4 types of vegetable crops is a better option for smallholder riverbed farmers who are still dependent on local *haats* and small markets.

Generally all riverbed farmers do not calculate the profit margin at farm level. A calculation on net profit from riverbed vegetable farming done by a leader farmer is presented in Table 2.

7. Constraints to riverbed vegetable farming

There are some constraints to riverbed vegetable farming common to all producer groups. Farming on the riverbed is seasonal and only one crop can be grown by farmers in a year. Soil is poor and requires high level of plant nutrient sources for good crop production. There is the problem of stray animals and vegetables are also stolen because riverbed farms are generally away from villages or settlements. Strong windstorms with sand particles damage plants severely every year. Due to long spell of droughts in recent years, there is need for irrigation on riverbed farming which further increases the cost of production. Farmers manually collect water in buckets from river and irrigate the crops. Rivers change thier courses every year and shifting of blocks for riverbed vegetable farming creates problems to farmers. Few farmers have dropped vegetable production on riverbeds due to low profit margin. In spite of these constraints, riverbed vegetable farming is an appropriate means of livelihoods of many landless and land poor families by utilizing the wastelands.

Table 2. Economic analysis of riverbed vegetable farming (area = 2 *Kattha* or 666 m^2)

Vegetable production cost (NRs.)						Incomes from vegetables (NRs.)					
SN	**Description**	**Unit**	**Qty.**	**Rate**	**Total**	**SN**	**Description**	**Unit**	**Qty.**	**Rate**	**Total**
A	**Variable cost**					**A**	**Incomes**				
1	Seeds					1	Income from sales				
	Water melon	gram	40	4	160		Water melon	kg	800	12	9600
	Bottle gourd	gram	15	4	60		Bottle gourd	kg	800	12	9600
	Cucumber	gram	8	5	40		Cucumber	kg	600	15	9000
2	Fertilizers										
	Compost	Qtl.	10	300	3000						
	Urea	kg	12	24	288						
	DAP	kg	8	40	320						
	Potash	kg	6	26	156						
	Borax	kg	0.5	200	100						
	Multiplex	ml	75	4	300						
3	Pesticides, hormone										
	Miraculan	ml	100	3	300						
	Pesticides	ml	300	2.5	750						
4	Labor cost	Person days*	20	250	5000						
5	Land rent	*Kattha*	2	300	600						
6	Marketing (transport)	No.	6	300	1800						
	Sub-total				12874						
B	**Fixed cost**										
	Depreciation on agri. tools	lump-sum	-	-	300						
	Sub-total				300						
	Total Cost (NRs.)				**13174**		**Total income (NRs.)**				**28200**
Net profit from 2 *Kattha* (666 m^2) area (NRs.)											**15026**

Note: *Payment for wage laboring is done on per person per day basis. In one day, wage laborer works for 7 to 8 hrs. depending on the season and nature of work

8. Lessons learned and opportunities

Cultivation of vegetables on riverbed is easy in terms of land preparation, cultural practices and irrigation management (usually do not require irrigation). The productivity and production of vegetables on riverbed is lower due to poor inherent soil fertility compared to permanently cultivated fertile lands. When compared with conventional vegetable farming, riverbed vegetable farming has been proved as an appropriate self-help livelihood option particularly for landless and land poor families. Experiences show that vegetables grown on riverbeds grow well and produce more than grown on riverbank areas. Adequate and judicious use of production inputs particularly quality seeds, compost and chemical fertilizers, pesticides and intensive care is needed to increase the productivity so that poor farmers can make reasonable profit from riverbed farming. Marketing is a major factor for the success of commercial promotion of riverbed vegetable farming. In the fresh vegetable value chain, the access of riverbed vegetable growers is limited to the local markets and they now need collective marketing system with improved access to wholesalers in the big end markets.

The area under riverbed and riverbank is increasing every year in the country due to erosion and floods during the rainy season which are the ultimate effects of climate change. There is large area of riverbed which is regarded as wastelands and can be properly utilized for riverbed vegetable farming. Riverbed vegetable farming has been emerged as a niche based on-farm income

generation activity and well accepted by farmers and agricultural organizations. Looking at this potential, Elam Plus/Helvetas, GTZ-INCLUDE, Micro Enterprise Development Program (MEDEP) under UNDP, Mercy Corps, District Agriculture Development Offices (DADOs) and some Non-Governmental Organizations (NGOs) have also been working to support landless and land poor families for riverbed farming. Joint efforts of these government and non-governmental organizations will be effective and sustainable for further scaling up/out of riverbed farming interventions.

9. Conclusion

There is significant area of land under riverbed and it is increasing every year. Among vegetables, cucurbits are commonly grown on riverbeds. The productivity and production of vegetables on riverbed is lower due to poor inherent soil fertility compared to conventional farming in permanently cultivated fertile lands. The average crop yields were recorded between 12.6 t/ha and 25.6 t/ha in Banke and Morang districts, respectively. Early harvested crops fetched good prices as off-seasonal vegetables. The farm gate price of vegetables was NRs. 20 to 25 per kg in March and NRs. 8 to 12 per kg during May/June. Approximately, 50% vegetable produced on riverbeds was sold in local *haats*, 30% in local markets and 20% to India.

Riverbed area is regarded as wasteland but riverbed vegetable farming is the major source of income of many landless and land poor families residing in the vicinity of rivers. The average per household income from riverbed vegetable farming in one cropping cycle was found to be NRs. 21,930.2 with a net profit ranging between NRs. 7,697.0 and NRs. 10,029.0. The leader farmers cultivating vegetables in more than 1320 m^2 (4 *Kattha*) riverbed area were able to earn more than NRs. 40,000.0 per cropping cycle. The benefit:cost ratio of riverbed vegetable farming was found to range between 1.4 and 4.8 when calculated for 20 farms. Income generated by riverbed vegetable growers were used primarily for meeting household food security. More than 12% of landless families purchased land using the income from vegetables and became land owners.

The seasonal nature of cropping, high level of plant nutrient requirements, problem of stray animals, damage by strong windstorms and long spell of droughts are the major constraints to riverbed vegetable farming. On the other hand, vegetable farming on riverbed is easy in terms of land preparation, cultural practices and irrigation management, and thus is an opportunity for landless and land poor families. Riverbed vegetable farming has been emerged as a niche based on-farm income generation activity for landless and land poor families and well accepted by farmers and agricultural organizations. Looking at this potential, joint efforts of government and non-governmental organizations are needed for effective and sustainable scaling up/out of riverbed vegetable farming interventions in the Tarai of Nepal.

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Endnote

[1] Landless families are those who do not have any land in their ownership. Land poor families are those who have land ownership but their landholding is either very small (less than 0.17 ha) or they have degraded land like riverbed/ riverbank area.

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