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Financial analysis of a participatory integrated livelihood security project in foothills of North Western Himalayas

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ABSTRACT

Rain dependent farming in North Western Himalaya (NWH) is in a vicious cycle of livelihood insecurity-resource degradation. This vicious cycle was unchained by employing participatory knowledge generated on resource conservation, production and local institutional mechanism in action during 2007-08 to 2013-14 in four villages of NWH. Tool-kit approach was adopted for boundary work, implementation and monitoring of the project and data analysis. Results showed that food deficit villages (before project) were converted in food surplus after the project, except pulses. The project generated ₹ 523.24 lakh Net Present Value (NPV) with a Benefit Cost (B:C) ratio of 2.59, and investment made can be recovered by 4 years at 10% discount rate considering 30 year period of analysis. Sensitivity analysis revealed that the project can sustain firmly under any odd situation of (i) rise in cost by 10%, (ii) decrease in benefits by 10% and (iii) reduction in project period by 50%, individually and their all possible combinations together. It is evident from the value of economic evaluation criteria; NPV of ₹ 203.26 lakh, B:C ratio 1.64:1, 6 years payback period and 48.3% Internal Rate of Return (IRR) under worst situation when all the assumed eventualities occur together. It can be concluded that such projects are financially sound investment venture and be replicated in other villages in the region. Natural resource management activities worked as catalyst in achieving sustainable livelihood security under rain dependent farming situation. Good boundary work for proactive participation of all stakeholders at all the three stages of project (planning, implementation and evaluation), jointly setting boundary objectives, strategies; and finally aligning local institutional mechanism in place towards ensuring benefit flow in perpetuity that holds the key for success of rain dependent agricultural projects.

1. INTRODUCTION

Uttarakhand is one of the fastest growing economies in India in past decade. The State economy grew at the rate of 12.75% compounded annual growth rate 2004-05 to 2013-14, whereas the Indian economy and in adjacent State *i.e.* Himachal Pradesh grew at the lower rate of 7.59 and 7.78% during the corresponding period (Govt of Uttarakhand portal, www.uk.gov.in). Though agriculture sector holds important place in the state, about 45% of main work force livelihood depends on it. But the share of agriculture in overall Gross State Domestic Product (GSDP) has declined from 22.27% in 2004-05 to just 10.27% in 2015-16. Tertiary sector which includes (Trade, Transport, Banking *etc.*) contribution to GSDP in 2014-15 was (about 36.07%) to the State kitty and it is expected to grow in future primarily owing to

money order economy. The secondary sector (manufacturing, construction, electricity *etc.*) contributed maximum (53.66%) in 2014-15. It clearly indicates that agriculture sector is lagging behind other sectors of state economy. Thus income disparity between agriculture dependent and other sectors workers is increasing over time. This situation is not a good indicator of social equity and may lead to conflict in future.

Arable land is about 13% of total reported area of the Uttarakhand state. Nearly 78% of arable land is rain dependent and dominated (91%) by marginal and small fragmented land holdings. Thus, there is no scale of economies in agricultural production. Mixed farming involving crops, horticulture, silvi-pastoral and animal husbandry at subsistence level has been the mainstay of the Uttarakhand agriculture (Dhyani *et al*., 2009; Dhyani, *et al*., 2006; Samra *et al*., 1999; Murganandam *et al*., 2013 and Raizada *et al*., 2008). The state agricultural production problem is further compounded by inaccessibility, marginality, fragility and many other constraints (Samra *et al*., 1999 and Dhyani *et al*., 1997). High population pressure coupled with un-scientific land use practices and high intensity rainfall pattern has resulted into high degree of land degradation (Sharda *et al*., 2013) and loss of 0.37 Mg food production every year (Sharda *et al*., 2010). With the result, the state has to import food commodities to meet the domestic requirements. Food imports at prices below the cost of local food crop production works as two edged sword. It under cuts the interest of local farmers in management of local resources *e.g.* water, land, vegetation, and livestock leading to abandonment of agricultural land and out migration in one hand, and on the other it increases dependency on imported food. Thus achieving livelihood security at local level is a serious problem that had larger impact on the society as a whole in the rain-dependent farming areas (FAO, 2008 and Dhyani *et al*., 2002).

Aase *et al*., 2009; Cline, 2007; Kumar *et al*., 2012 and Singh *et al*., 2010 have indicated that Himalayan region is more vulnerable to climate change and suggested to develop proper adaptation strategies to cope-up. Farmers require choice of technological options to respond challenges associated with their diverse needs and resource availability that address the increasing complexity of stress under which they operate. Research and development institutions in the country have developed a good number of technologies in the field of agriculture and natural resource management, which are individually technically feasible, economically viable, eco-friendly and often scale neutral. Efforts are required to put this information into action in proper perspective at farmers' field after converting them into knowledge with participation of primary stakeholders. Therefore, an inter-disciplinary on-farm research project with farming systems perspective was undertaken by ICAR-Indian Institute of Soil and Water Conservation (formerly CSWCRTI), Dehradun, during 2007-08 to 2013-14 to demonstrate efficiency and efficacy of selected technologies for developing live model on livelihood security in foothills of NWHs with financial support from Ministry of Rural Development, Government of India The paper presents result of the project on food production, food sufficiency and economic viability aspects from the project.

2. MATERIALS AND METHODS

The project site is located between 32°27′ to 32°27′N Latitudes and 77°51′45″E to 77°54′E Longitudes in foothills of NWHs. All the 321 farm families of the selected villages namely, Dungakhet, Pasauli, Devthala, and Godaria in Dehradun district of Uttarakhand were adopted. Transect walk of the area and preliminary discussion with farmers indicated poor natural and cultural resource base, poor land productivity status, meagre financial resources with high degree of inequality and disguised un-employment situation in the area. Development of common broad objectives, finalization of doable technological options, implementation strategies, local institutional mechanism and active participation of primary stakeholders are the initiation points of a agricultural development project. All these activities together were termed as boundary work.

Boundary Work: Boundary work is one of the promising instruments for facilitating knowledge co-production, collaborative implementation and linking diverse stakeholders. Cash *et al.* (2003) have defined boundary work as a set of measures aligned by an organization that seek to mediate between knowledge and action. In other words, boundary work consist of efforts made by the Project Implementation Agency (PIA) towards resolving tension/conflict which arises at the interface between

stakeholders and PIA owing to different views on relevancy of particular knowledge, acquaintance level, perceptions and experiences among stakeholders (Cash *et al.*, 2003). Good boundary work helps in better understanding and managing the challenges that may arise from the interactions between stakeholders involved in production and use of knowledge, and its transfer into action. Clark, *et al.,* 2016 have identified three attributes of boundary work *i.e.* participation, accountability and boundary objectives, to increase the likelihood of success of the project. Participation in this context refers to agenda setting and knowledge co-production with open mind detailed discussion among stakeholders. Accountability refers to local governance mechanism put in place for sustainability of created assets. Boundary objectives are collaborative product which are intended to achieve and adaptable by Participatory Stakeholders (PS). A good boundary work has to imbibe ecological-socio-cultural system to produce knowledge that can be put in action under dynamic sustainable system. This can be achieved through effective context analysis. Context analysis offers clues to understand the problems that stakeholders face and provide a basis for alternatives including forces, actors, deeds and events that come about as a result of political, social, cultural, technological and economic dynamics. Thus a meaningful boundary work require proper integration of techniques from different disciplines required for agenda setting and knowledge co-production with meaningful participation and accountability.

Confidence building on PIA and proposed interventions is prerequisite of good boundary work to create mass awareness among PS before formulation of a project. A series of exposure visits of PS to successful similar project sites were conducted. A working group representing PS from each village and their Panchayati Raj Institutions (PRI) got convinced to sign the Memorandum of Understanding (MoU) containing collaborative broad objective, interventions, implementation modalities and their participation. The project proposal was submitted to the state government for approval. On the recommendation of state government the funding agency approved the project. Local community based organizations were formed before initiation of a community based interventions and were made accountable for cooperation and sustainability of community resource created. Thus three attributes of boundary work *i.e.* participation, accountability and boundary objectives as defined the Clark *et al.,* 2016 were met.

Participatory Rural Appraisal (PRA), orthodox techniques of soil science, engineering, plant science, animal science, extension and socio-economic disciplines for data collection and analysis were employed for situation analysis of project. Implementation strategy for each intervention was developed by applying management tools, namely, Relevance-Importance-Constraint (RIC) and Force-Field Analysis (FFA) techniques. Basket of technological options was planned for each farm typology, and implementation strategy was finalized after triangulating the proposed plan with PS. Project was implemented during 2007-08 to 2013-14 with a total cost of ₹ 85.70 lakh. All interventions were implemented with active participation of primary stakeholders with legitimacy. Interventions were monitored and evaluated concurrently in participatory manner involving PS. Data were analysed applying suitable techniques of the respective discipline. Results were presented in the joint meeting of stakeholders after six month in farmers' open meeting, termed as *kharif/rabi* meeting (*Goshties*). Minor modifications in planned interventions and implementation strategies were also made based on results of concurrent evaluation done jointly by PIA and PS. implementation plans were divided into two groups, *viz.,* on-farm interventions and community interventions based on farmers contribution as per donor agency norms. Group of interventions benefitting an individual farmers were termed as on-farm intervention and beneficiary farmer contributed 40% of total intervention cost in the form of human labour. The interventions aiming to benefit the group of farmers or community in general were termed as off-farm interventions. Although there was no compulsion of contribution from farmers in community intervention, farmers were convinced to contribute as much as possible. Details of the interventions finalized are described in Dhyani *et al.,* 2015 and Kumar *et al.,* 2017 and finally implemented are presented under results and discussion section. Budgeting technique was employed in general for data analysis.

Total Maize Equivalent Production (MEP)

Annual cultivated land was budgeted for each crop with technology followed by the farmers of each village. Annual crop production of a crop variety was estimated by multiplying total area under particular crop variety in a village by average yield of respective crop variety in that village. Total production of a particular crop was estimated by summing up of total production of that crop in all adopted four villages. To estimate total crop production from the area, simple summation was followed. Therefore, all crop productions were converted into MEP to make it comparable over time. Total MEP was estimated by multiplying total production of a crop by a constant *i.e.* price ratio of that crop in 2013 to maize price in the year 2013 and summed up horizontally. Thus total crop production was made comparable over time.

Food Sufficiency

Results of dietary survey by Indian Council of Medical Research (ICMR) concluded that diets of poor are grossly inadequate and require phenomenal improvement in their economic status to afford adequate diet. The food sufficiency in the project area was estimated by comparing the total availability (production) of each food group with total requirement of respective food group. Total requirement of a food group was estimated by converting actual human population in standard human population and multiplied by requirement of a villager as moderate worker as per ICMR standards for Pre Project (PrP) 2007-08 and End of Project (EoP) Period. The procedure followed is explained by the following notation:

$S_{dt} = \sum A_{idt} Y_{idt} - \sum r_{id} P_t$; A = Area of i^{th} crop of d^{th} food group in period t, Y = average yield of i^{th} crop of d^{th} food group in period t, r = per annum requirement of d^{th} food group for a standard moderate human worker, P_t = standard human population in t^{th} year, S_{dt} = sufficiency/deficiency of d^{th} food group in t^{th} period, i = i^{th} crop of d^{th} food group, d = food group (cereal, pulses, vegetables, oilseeds), t = time (PrP 2007 and EoP 2013).

Where, i = 1…….....….16, d= 1…....…..…6, t= 1, 2.

Milk sufficiency (s_t) = Availability (y_t) – Requirement ($r P_t$).

$s_t = y_t - r P_t$

Where, y_t = total milk production, and r = per annum requirement of milk for a standard moderate human worker.

The indicator may attain any value. High positive value indicates the marketable surplus(s) of respective food group, which clearly manifests farmers' income can be enhanced by converting marketable surplus into marketed surplus at appropriate prices. Marginal positive value reflects just sufficiency. A negative value shows the deficit of respective food group and suggest for its import to improve their nutritional intake for good health as per ICAR recommendations.

Financial Analysis

B:C Analysis of the project was carried out for the project by considering 30 years project life and 10% discount rate by adopting partial budgeting technique. Famers' technique/pre-project situation was considered as control for this purpose. Whole project was divided into three sectors *i.e.* crop, horticulture and livestock. Crop sector include water resource development, distribution system and minor land shaping and expenses on them was termed investment cost and included in the year when it was incurred. Annual marginal input (seed, fertilizer, plant protection measures, labour, water charges etc.) used in production process and output(s) produced from them were estimated for each enterprise. Physical quantities of the additional inputs used and outputs produced (including joint products) were converted into monetary term by multiplying average price of the respective items as declared by the government of India/government of Uttarakhand or local market during 2008 to 2013 in the order of preference and kept constant for whole period of analysis. Five percent of investment cost was added to the sector's annual expenses *i.e.* annual maintenance cost, to arrive total additional recurring cost for the year. Sum of investment cost and total recurring cost was termed as total additional cost to the enterprise for respective year. These additional costs and benefits were termed as marginal costs and marginal returns respectively. Area allocated by the farmers for each crop based activity for each year were multiplied by marginal cost/benefits for that crop to obtain annual gross additional cost and return for a year to the particular crop. These marginal costs/ returns from all crop based enterprises were summed

up horizontally every year to estimate crop sector total marginal cost/benefits for the respective year.

Yearly plantation cost including cost of planting material, pit digging, filling of mixture and labour required up to plantation was considered as investment for horticulture sector and all other costs were considered as operational expenses. In case of horticultural development only mango plantation was considered for economic analysis as mango plantation was most prominent horticulture fruit crop planted under project. Plants were distributed into non bearing, initial bearing and mature bearing stage each year as per technical recommendations based on year of plantation. Average inputs used and output produced were estimated and monetized as per procedure explained for annual crop production. In case of livestock sector, no improved livestock was provided to the project site as PS motivated for improving fodder quality/ availability and discouraging in open grazing. Hence, capital cost include additional cost of improved livestock purchased, which is a difference of cost of improved livestock purchased and receipt from sale of less productive animals and initial investment on afforestration and grass plantation/sodding on field bunds. All additional operational expenses for livestock rearing and afforestation were taken as annual cost for this sector.

Financial analysis of the project as whole was worked out by developing new streams of marginal costs and benefits. Horizontal submission of all the additional costs or benefits from three sectors for each year was done. Capital cost of other activities *viz.,* trenching, gully plugging, river training and other SWC works carried out under the project were added to the newly generated cost stream as investment for the respective year. Five percent of this total capital cost was taken as annual maintenance cost and added to operational cost of respective year. Thus new cost stream for the project were estimated. Total marginal benefits from the project were obtained by simple summation of additional annual benefits accrued from crop, horticulture and livestock sector for each year of the project. Cash flow chart was developed for each sector and for total project independently and discounted at 10 % rate. Following statistics were used to workout financial analysis of the project.

Net Present Value (NPV): NPV is difference between the discounted value of total marginal benefits and discounted value of total marginal costs. The general formula for NPV is:

$$\text{Net Present Value (NPV)} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Where, B_t = total marginal benefits at time t, C_t = total marginal costs at time t, i = Discount rate (%), and t = Life of the project.

Higher positive NPV indicates more economically soundness of the project. A project having negative NPV value will be an economical failure and zero NPV shows no net gain from project.

Benefit:Cost (B:C) Ratio: Ratio of present value of total marginal benefits to the present value of total marginal costs as given below:

$$\text{Benefit:Cost (B:C) ratio} = \sum_{t=1}^{n} \frac{B_t / (1+i)^t}{C_t / (1+i)^t}$$

Where, B_t are the total marginal benefits at time t; C_t are the total marginal costs at time t; i is discount rate (10%); and t is life of the project (30 years). Economic soundness of the project increases as the B:C Ratio value increases.

Pay Back Period (PBP): Number of year(s) on which cumulative NPV first time gets positive and remain positive thereafter. Shorter PBP is better indicator.

Internal Rate of Return (IRR): Rate of discount which makes the present value of total marginal benefits equal to present value of total marginal costs. IRR is the discount rate 'i', such that:

$$\text{Internal Rate of Return (IRR)} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$$

IRR can be determined through iterative process. Substantially higher IRR than rate of interest to be paid on investment is better and should always be more than interest rate to be paid on investment.

Cost Effectiveness: This criterion indicates the relative efficiency of different sectors in overall efficiency of the project. It can be measured by estimating the ratio of percent contribution of a sector to present value of total marginal benefits to the total present value of marginal cost of the project. This can attain any value more than one. Higher value

indicates that the sector is comparatively performing better than other sectors of the project.

Sensitivity Analysis: Sensitivity analysis of all the three sectors of the projects and to the project as a whole was worked out assuming three risk situations namely if (i) marginal cost increased by 10%, (ii) marginal benefit reduced by 10%, (iii) project life reduced to 15 years and their all combinations. All the B:C Ratio criteria were reworked out for each situation individually and for their all possible combinations and economic resilience of the each sector and project as a whole was tested. The project is said to be resilient against a particular risk situation or their possible combinations, if and only if, the NPV is positive, B:C Ratio is more than unity, IRR is sufficiently more than interest rate to be paid on investment *i.e.* discount rate and payback period is less than the period of analysis. Otherwise it is termed to be sensitive to that factor or their combination as per the situation.

3. RESULTS AND DISCUSSION

Results of the study are presented in three sections. First section describes the interventions implemented, second deals with changes in demography, MEP and food sufficiency during PrP and EoP period. Last section presents the financial analysis results.

Interventions Implemented: The project was aimed to achieve livelihood security through infusion of improved technologies on conservation and efficient

Table: 1
Activities implemented under project during 2007 to 2013

S.No.	Intervention	Unit	Achievement
A. On Farm Development on Private Land			
1.	Commissioning and execution of PVC pipe line	km	1.5
2.	Conservation bench terracing	ha	5.0
3.	Grass sodding on bunds	ha	50
4.	Dry land horticulture cum agro-horti system	ha	4.2
5.	Crop production and diversification of agriculture	ha	368.0
6.	Improved composting	no	15.0
7.	Rice fish culture	no	10.0
8.	Pond pisciculture	units	13.0
B. Off Farm Development (Community based)			
1.	Community pond (Masonry)	no	1.0
2.	Commissioning and execution of GI pipe	km	1.9
3.	Rejuvenation of earthen water harvesting structure with LDPE lining for pisiculture (270 cum)	no	Pisciculture demonstrated
4.	Afforestation and silvipastoral development	ha	25.0
5.	Contour trenching	ha	7.0
6.	Dry land horticulture	ha	3.0
7.	Drainage line treatment (Gabion structure, gully plugs and vegetative barriers)	no	98
8.	Plantation of bio-fuel and other vegetative species in degraded lands	ha	12
9.	Income generating activities through SHG's for landless and marginal farmers		
	a. Mushroom cultivation units	units	9
	b. Bee keeping	units	5
C. Livestock Development			
1.	Ecto parasite control	no	5523
2.	Endo parasite control	no	5523
3.	Vaccination against FMD, HS&BQ	no	5622
4.	Urea treatment of straw/dry fodder	no	52
D. Training and Extension			
1.	Exposure visits (20 farmers in each group)	no	8
2.	Farmers training	no	27
3.	*Kishan ghosties*	no	8
4.	*Kishan mela*	no	1

utilization of land, water, animal and vegetation resources. Demonstrations of improved cropping, horticulture, livestock and afforestation interventions along with capacity building programmes and income generation activities was carried out (Table 1). It is evident from the Table 1 that a variety of interventions addressing multiple aspects of livelihood security were introduced. Technical collaboration was established with Central Govt. Khadi and Village Industries Commission (KVIC), Dehradun unit and state government (Animal Husbandry, Horticulture) Departments during implementation of those activities where the institute did not have expertise. A good number of exposure visits of farmers and their groups were organised to create awareness, develop confidence on technologies to be adopted and show the credibility of implementing agency. Intervention oriented focused training programmes (27 in number) were organized either at project site or outside of project as per requirement and ease to farmers and resource person(s). *Kishan Ghosties* were organized well before *kharif* and *rabi* crop seasons every year and utilised for discussion on results of last year demonstrations, finalization of plan for coming season, development of implementation strategies and any other issue related to intervention. Based on concurrent evaluation, sericulture activity was not introduced as selected farmers did not show keen interest and beekeeping was found uneconomical owing to presence of wild insect in non arable land. Finally, *Kishan Mela* (farmers' fair) was organised at the end of project period to disseminate results of the project as perceived by the adopted farmers for wider extrapolation of technically feasible, socially acceptable and economically viable technologies in the area.

Demographic Changes: Demographic analysis for two periods *i.e.* 2007 (PrP) and 2013 (EoP) revealed a marginal increase (4%) in total number of families during this period (Table 2). It is primarily attributed to subdivision of existing families. Total standard human population increased by 10% during the same period indicating 2% per annum simple growth rate. Female: male ratio remained largely unchanged. Increase in total human population indicate higher demand for food items and expected continue to grow in future. Therefore sustained efforts are required to achieve food sufficiency for growing human population.

Maize Equivalent Production (MEP): Total MEP from the arable land is presented in Fig. 1. The figure indicates that MEP from the area is continuously rising from base year to 2012. It increased by 81% in 2009, by 205% in 2010, over 2008 production. It continued to rise by 3.3 times in 2011 and 3.7 times in 2012. In 2013 total MEP declined as compared to 2012 due to unprecedented heavy rainfall. However, 2013 MEP was also 2.7 times more than PrP (2008) MEP level. Thereby maize equivalent productivity of arable land increased from 76.5 q ha^{-1} in PrP to 135, 195, 200, 212 and 156 q ha^{-1} in subsequent years, respectively.

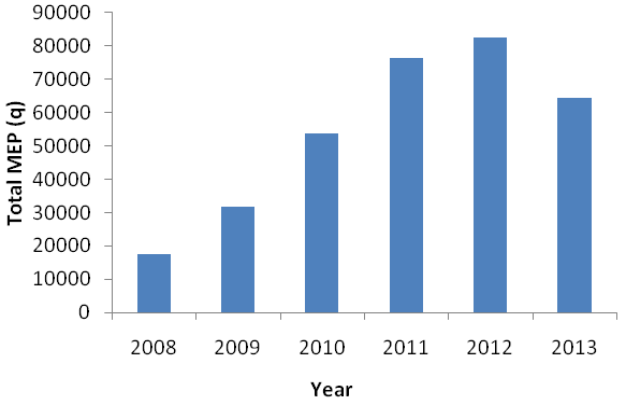

Fig. 1. Total Maize Equivalent Production (MEP) in different years

Table: 2
Details of demographic changes in adopted villages during 2007 and 2013

Village	No. of Families			Standard Human Population			Male: Female Ratio	
	2007	2013	Change (%)	2007	2013	Change (%)	2007	2013
Dungakhet	34	34	0.0	237	282	19	1:0.98	1:1.0
Pasauli	105	106	0.9	673	685	2	1:1.01	1:1.0
Devthala	151	158	4.6	905	1022	13	1:1.0	1:0.99
Godaria	31	36	16.1	182	214	18	1:1.0	1:1.01
Total	321	334	4	1997	2203	10	1:1.0	1:1.01

Food Sufficiency: Ultimate aim of the project was to achieve livelihood security of the primary stake-holders. It was measured in terms of food requirement of primary stakeholders is met and marketable surplus generated for sufficient income to fulfil their other demands. It was measured in 2007 and 2013 by employing Indian Council of Medical Research 2000 recommendations and budgeting technique. The data presented in Table 3 shows that project area had marginal marketable surplus of spices and milk in 2007 and deficit in all other food items. Standard human population in the project area was increased by 10.3% during 2007 to 2013. This increases demand of all food items by 10.3%. Table 3 amply demonstrate that the area had sizable quantity of marketable surplus of all the food items except pulses owing to poor soil quality and micro agro-climatic conditions for the crop group. In overall, the total quantity of marketable surplus increased by 9.25 times. Adopted villages are easily accessible to market located at Vikas Nagar, Dehradun and Saharanpur. Hence, marketable surplus was equal to marketed surplus. Further, farmers' do not go for stress sale for majority of their items and tries to get best price for their farm produce. Ginger and colocasia are sold as seed and maize is sold to local poultry farm during February to May. Wheat and paddy are also sold for seed purpose to the farmers of the other villages in the region. Milk is sold through Anchal Dairy Cooperatives by majority of the farmers. Vegetables are sold through farmer group basis in local market of Vikas Nagar or Dehradun which fetches good prices to them. Therefore, agriculture has changed from subsistence level to source of income generation. This is attributed to good boundary work resulting in proactive participation of PS, faster diffusion of demonstrated technologies within adopted villages, and crop diversification. Avenues for generated marketable surplus facilitated to good income generation and motivated farmers to adopt on large scale.

Financial Analysis: The results of B:C Analysis for average situation of the project are presented in Table 4. The results reveal that crop production sector generated ₹ 253.05 lakh NPV with B:C Ratio of 2.78:1 and payback period of one year only. The IRR value for crop production sector is so high that it goes beyond calculation. The positive economic appreciation is attributed to lower level of capital cost in relation to area under crops, lower additional expenses, increase in cropping intensity and fast diffusion of improved crop production technologies in the area. Horticulture sector produced 59.30 lakh NPV with 4.56:1 B:C Ratio. The sector has potential to repay the initial investment within 11 years with IRR

Table: 3
Food sufficiency status during 2007 and 2013

Crop	Per person requirement (q/annum)	Total requirement (q/annum)		Production (q/annum)		Marketable surplus/deficit	
		2007	2013	2007	2013	2007	2013
Cereals	2.01	4023.40	4438.40	3754.73	7621.49	(-)268.62	3183.10
Pulses	0.18	349.90	385.97	104.89	130.49	(-)244.99	(-)255.49
Vegetables	0.70	1399.50	1543.86	24.20	1711.35	(1375.30	167.49
Spices	0.03	51.92	57.28	1872.97	7512.16	1821.04	7454.89
Milk*	0p.66	1312.03	1447.37	2300	5630	987.98	4182.63
Oilseeds	0.18	349.47	385.53	37.12	437.02	(-)312.36	51.49
Total	3.75	7486.15	8258.39	8093.91	23042.50	607.76	14784.11

**measured in '00 liter*

Table: 4
Benefit Cost Analysis of project (30 years life and 10% discount rate)

Criterion	Sector			
	Crop	Horticulture	Livestock	Total project
Net Present Value (NPV)	25304610	5930002	23730361	52324119
Benefit:Cost (B:C) ratio	2.78:1	4.56:1	2.67:1	2.59:1
Pay Back Period (PBP) years	1	11	6	4
Internal Rate of Return (IRR%)	-	31.55	101.3	147.63

to the tune of 31.55%. Livestock sector is the second best sector in terms of all the indicators except B:C Ratio. This sector generated NPV to the tune of 237.3 lakh with a B:C Ratio of 2.67:1. This sector can repay the investment within 6 years with 101% IRR. In overall, the project had a potential to generate 523.24 lakh NPV with 2.59:1 B:C Ratio and money invested together by the project and farmers can be recovered within 4 years with 147.6% IRR. The analysis amply revealed that all the three sectors of the project and project as a whole is a good economic venture for investment.

It is worth to analyze the differences in relative contribution of each sector for overall feasibility of the project. This was done by cost effectiveness criteria (Table 5). The relative efficiency indices of these sectors indicated that horticulture sector is most rewarding with cost effectiveness ratio of 1.76 and efficient in making the project economically viable. Agriculture and livestock sectors are at par (with ratio of 1.07) in making the project worth to take up.

Sensitivity Analysis: The period of analysis considered was 30 years. During this long period, project activities and outputs may encompass a variety of uncertainties owing to one or the other reasons. Therefore, to test the potentiality of the project to withstand firmly against any possible odds was judged by sensitivity analysis. Project costs, outputs and period of analysis were considered the major attributes for sensitivity analysis. Project evaluation criteria were reworked out under (i) Project cost increased by 10%, (ii) Benefits from project reduced by 10%, every year and (iii) Project life reduced to 15 years and (iv) all possible combinations of each variant and project as a whole. The results are presented in Table 6. Sensitivity results showed that all the sectors as well as project as a whole was least sensitive in terms of PBP criterion with all the sensitivity attributes individually and their all possible combinations (Table 6). The IRR values declined marginally with a change in all the three criteria and their combinations. The B:C Ratio criterion also shows sensitivity and NPV was highly sensitive with respect to selected criteria and their combinations. Reduction in project life by 50% had reduced NPV and B:C Ratio values drastically as compared to others. However, all three sector as well as project as a whole remained economically viable fairly and can be termed as resilient one. Agriculture sector showed higher level of resilience followed by horticulture, and livestock. However, even under the worst situations, all the sectors of the project and project as a whole remained attractive and fairly reflected by the positive economic values of economic evaluations criteria indicating that project is worth to replicate in similar agro-ecological situations in the north-western Himalayas for livelihood security of rain dependent farming community.

4. CONCLUSIONS

Farmers are system thinker by nature. A farmer looks at all enterprises on his farm as a single business unit and his endeavours to maximise his economic gain by blending the technical know-how with his socio-economic condition and biophysical resources on his hand in decision making. Research institutes have generated a number of individual technologies (knowledge) in the field of management of natural resource and efficient production in different aspects of farming. There is a need of efficient institution(s) and dedicated multi-disciplinary team to mediate between knowledge and action by performing reasonable boundary work at project level to achieve livelihood security and make rain dependent agriculture a profitable venture. Application of simple management tools in project planning and its implementation lead to sustainability of project outcome. Inclusion of project management tools at graduate level education will develop good future project managers.

Table: 5
Cost effectiveness of the project

Percentage share in total	Total and Percent share of sector						Total
	Crop	(%)	Horticulture	(%)	Livestock	(%)	
Cost	14242446	(43.31)	1664980	(5.06)	14238595	(43.29)	32886875
Benefits	39547056	(46.41)	7594982	(8.92)	37968956	(44.61)	85110994
Cost effective ratio (B/C)	1.07		1.76		1.07		-

Table: 6
Sensitivity of the project with respect to various economic parameters and their combinations

Sector	Criterion	Situation			I and II together	I and III together	II and III together	I, II and III all together
		Cost increase by 10% (I)	Benefits decreased by 10% (II)	Project life reduced to 15 years (III)				
Crop	NPV (lakh)	238.80	213.50	186.82	199.25	175.45	156.77	145.41
	B:C Ratio	2.52:1	2.5:1	2.64:1	2.27:1	2.40:1	2.38:1	2.16
	IRR (%)	-	-	-	-	-	-	-
	PBP (years)	One	One	One	One	One	One	One
Horticulture	NPV	57.63	51.70	24.75	50.04	23.57	21.09	19.91
	B:C Ratio	4.15:1	4.11:1	3.09:1	3.73:1	2.81:1	2.79:1	2.53:1
	IRR	30.17	30.0	28.7	28.67	27.16	27.0	25.4
	PBP	12	12	12	12	12	12	12
Livestock	NPV	223.06	199.33	190.74	185.09	179.18	160.10	148.54
	B:C Ratio	2.42:1	2.40:1	2.65:1	2.18:1	2.41:1	2.39:1	2.17:1
	IRR	81.5	79.8	101.34	65.7	81.49	79.77	65.7
	PBP	6	6	6	6	6	6	6
Overall	NPV	456.19	360.53	378.51	294.48	325.51	256.27	203.26
	B:C Ratio	2.16:1	2.10:1	2.43:1	1.74:1	2.02:1	1.97:1	1.64:1
	IRR	82.58	75.65	147.06	48.59	81.5	75.6	48.3
	PBP	6	6	4	6	6	6	6

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