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CONTENTS

Economics of interventions and diversifications in existing farming systems in hills of Uttarakhand

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ABSTRACT: Integrated farming in hilly regions can be a sustainable way to provide income and employment to farmers. Keeping in view the importance of the Integrated Farming System in substantially increasing the profitability and livelihood of households, an attempt was made to introduce and study the feasibility of the best possible interventions & diversifications in the prevailing farming system in the hills of Uttarakhand and create awareness among farmers about these income-generating enterprises. The present study was conducted in the district of Nainital during 2011-12 to 2015-16. For this study, from the hilly region of district Nainital, one high productivity block (Kotabagh) and one low productivity block (Bhimtal) were selected on the basis of secondary data, in each block, three villages were selected randomly for the study. A total of ten farmers participated in the study. For the experimentation, the farming system was studied under different modules: Crop module, livestock module, value addition & processing module, and optional module. The module-wise benchmark data of farm families collected through farmer participatory research from a system perspective to identify the constraints in each module. The module-wise constraints were addressed with low or no-cost-effective and environmentally safe technological interventions and diversifications with suitable enterprises. The mean total cost of farming systems was Rs.116,634 during the benchmark year (2011-12), with additional costs on interventions and diversification, it increased over the years, and it was recordeda highest (Rs.171,372) during the fourth year of experimentation (2015-16). The mean gross return from farming systems of participating households was Rs.193,911 during the benchmark year and it increased over the years and it was recorded highest (Rs.351,134) during fourth year of experimentation due to increased production in different module and due to additional income from value addition & processing of agricultural produce and additional income from diversification of farming systems of participating households. The mean net return increased from Rs.77,277 during the benchmark year to Rs.179,760 during the fourth year of experimentation. The benefit:cost ratio also improved over the subsequent years from 1.66 during the benchmark year to 2.05 during the fourth year of experimentation.

Keywords: Diversifications, farming system, interventions

Among the 34 million people that inhabit the Himalayan region, of a large percentage is from the hill farming communities (including mountains). They sustain largely on subsistence farming, which is practiced on marginal rainfed and some irrigated farmlands occupying 15.8 per cent of the total area of the Himalayas *i. e.,* 53.8 million hectares. The rest of the Himalayan landscape includes rangelands, pastures, wastelands, the so-called bushland, grazing areas, and the forests; all these accounts for nearly 69 per cent of the Himalayan area. Another 15.2 per cent is under permanent snow cover and rocky mountains, which serves as a perennial source of clean water to the hill people as well as to the nation. Agriculture is the primary sector of the economy, contributing 45 per cent to the total regional income of the inhabitants. A great chunk of the farming households in the Himalayan states have landholdings of less than 0.5 ha or small landholders with farms of 0.5 to 1.0 ha.

Uttarakhand's agriculture is predominantly rural and forms the backbone of its economy. Hill farming, constituting about 70% of the agricultural activities in the state, provides sustenance to small and marginal farmers (Govt. of Uttarakhand, 2022). However, with fragmented landholdings and erratic climatic conditions, the farming system faces signifi-

cant challenges (Rawat, 2020). Hill farming in Uttarakhand primarily involves subsistence agriculture, constrained by land-locked geography and market distances. The development strategy suggests diversifying agriculture towards high-value crops and promoting tourism to enhance livelihoods and reduce migration from these hill districts (Mittal *et al.,* 2008). Agriculture in the hills is predominantly subsistence-oriented, characterized by small landholdings (average size 0.67 hectares) and terrace farming on steep slopes (Govt. of Uttarakhand, 2022). Rainfall accounts for 75% of water availability during the summer cropping season, but much is lost through runoff due to inadequate soil and water conservation measures (ICAR, 2020). This region supports the cultivation of cereals (wheat, rice, maize), pulses, oilseeds, fruits, vegetables, and medicinal plants. Despite these advantages, the system faces multiple constraints, including poor infrastructure, climate variability, and out-migration of the farming population.

Integrated farming systems (IFS) that integrate animal and crop enterprises are receiving renewed interest in marginal, small, and medium farmers (Behera *et al.,* 2013; Behera and France, 2016), who cultivate less than one hectare. Efficiently managed IFS are expected to be less risky, as they benefit from enterprise synergies, product diversity, and ecological reliability (Behera and France, 2016). Integrated farming is a system that combines multiple agricultural practices on a single farm to improve efficiency and sustainability. Integrated farming comprises cropping methods and other agricultural production techniques which fulfil both ecological and economic demands. Integrated farming in hilly regions can be a sustainable way to provide income and employment to farmers. It combines cropping methods and other agricultural techniques to meet both ecological and economic needs. In the undulating topography and climatic vulnerability of hill ecosystems, IFS can be a highly productive, proûtable, and sustainable approach. The presence of multiple components minimizes the risk and provides a sense of security to the producers. The resource-saving and waste recycling practices are cost-effective and sustainable, and also minimize the negativities and risks associated with intensive cropping. The integration of farming systems provides ûow of capital around the year by way of the disposal of milk, eggs, honey, edible mushrooms, meat, etc. This takes care of the nutritional requirements of the farm family, besides ensuring a better and sustainable livelihood.

Keeping in view the importance of the Integrated Farming System in substantially increasing the profitability and livelihood of households, an attempt was made to introduce and study the feasibility of the best possible interventions & diversifications in the prevailing farming system in the hills of Uttarakhand and create awareness among farmers about these income-generating enterprises.

MATERIALS AND METHODS

The present study was conducted in the district of Nainital during 2011-12 to 2015-16. For this study, one high productivity block (Kotabagh) and one low productivity block (Bhimtal) were selected on the basis of secondary data. From each block, three villages were selected randomly for this study. A total number of ten farmers were selected for the study. For the study, first the farming system was studied under different modules: Crop module, livestock module, value addition & processing module, and optional module. The module-wise benchmark data of farm families was collected through farmer participatory research from a system perspective to identify the constraints in each module. The module-wise constraints were addressed with low or no-cost-effective and environmentally safe technological interventions and diversifications with suitable enterprises.

During the first year (2011-12), the benchmark survey of farming systems of participating households was done.

Based on the information generated during the benchmark survey, the existing farming system was identified as crops + dairy. Then module-wise technical programme was prepared to address the constraints identified with suitable interventions and diversifications.

In crop module interventions like recommended plant

geometry (line sowing of wheat in place of broadcasting of seeds and transplanting of rice in rows with 40-50 hills per square meter) & recommended fertilization (nitrogen, phosphorus and potassium) in rice & wheat, plant protection measures in vegetables & horticulture crops and gap filling of orchards, and inclusion of vegetable pea, onion, French bean, potato, okra, gram and lentil crops in cropping systems of participating households for better returns were taken up.

In the livestock module, the following interventions were followed: mineral mixture supplementation for milking cows/buffaloes, de-worming drugs for weak animals, round-the-year fodder supply by inclusion of Napier grass & maize + cowpea during summer for fodder, and maintenance of hygiene and sanitation of the cow shed. In case of value addition & processing module, Gaddi making (packing) of coriander and grading and packing of other vegetables (tomato, onion, pea, potato, and okra) before marketing was done to fetch a better price for the produce. Under the optional module, diversification of farming systems was done with the introduction of papaya and cucurbits production on unutilized space near home, coriander and chilli production during summer and rainy season, introduction of backyard poultry, and initiation of vermi-composting were done to enhance the overall productivity and return from the farming system.

The different critical inputs (free of cost) were provided during different years to the participating households from 2012-13 to 2014-15 to initiate different interventions and diversifications; hence, all interventions and diversifications were taken up to the third year of experimentation (2014-15). The intervention/ diversion cost was included in the cost of cultivation. During the fourth year of experimentation (2015-16), free input support was not provided; the participating households were provided with only the technical support.

All the required agri-inputs were supplied to the farmers by the Department of Agronomy, GBPUA&T, Pantnagar, and were funded by ICAR-IIFSR, Modipuram, Meerut, U. P.

RESULTS AND DISCUSSION

A benchmark characterization survey was done to start the study in 2011-12. This survey revealed that the existing farming system of all the selected households was crops + dairy, the mean holding size was 0.72 ha, the mean family size was 5, and the mean total net income per household before the start of the study per annum was recorded as Rs 77,276 (Table 1).

The results on module-wise economics over the years have been presented in Table 2. In crop module (field crops, vegetable crops and horticulture crops), following constraints were identified of participating households: uneven transplanting (improper plant spacing) in rice crop, broadcast sowing of wheat crop, lesser than recommended and no phosphorus & potassium fertilization of rice and wheat crop, prevalence of diseases & pests in vegetable &horticulture crops and low income from cropping systems of participating households during the benchmark year.

In crop module, the mean cost of cultivation was Rs.51,985 during the benchmark year (2011-12) and it increased over the subsequent years and it was recorded highest (Rs.72,189) during the fourth year (2015-16) due to inclusion cost of inputs for interventions and diversifications: recommended plant geometry &recommended fertilization in rice &wheat, inclusion of vegetable pea, onion, French bean, potato, okra, gram and lentil crops in the cropping system for better returns, plant protection measures in vegetables & horticulture crops and gap filling in orchards. The mean gross return from crops increased over the years from Rs.137,296 during the benchmark year to Rs.208,289 during the fourth year (2015-16) due to higher productivity of existing crops and diversification with remunerative vegetables and pulse crops. The net return also increased from Rs.85,311 during the benchmark year to Rs.136,098 during the fourth year (2015-16) of experimentation.

In the livestock module, the constraints identified were as follows: weak and less productive animals due to malnutrition and abdominal worms, less fodder availability, particularly during summer, unhy-

gienic conditions, and no proper aeration or ventilation in the cow shed.

In livestock module, the mean cost of cultivation was Rs.64,649 during the benchmark year (2011-12), it increased over the years of experimentation due to interventions of mineral mixture supplementation, de-worming drugs, round the year fodder supply by inclusion of maize + cowpea & Napier grass on bunds and by maintaining hygiene and sanitation in cow shed. During the fourth year (2015-16), the mean cost of cultivation in the livestock module was recorded as Rs.89,923. The mean gross return from the livestock module increased from Rs.56,615 (benchmark year) to Rs.100,636 in the fourth year (2015-16) due to increased milk production. The mean net return from the livestock module was Rs.8034 in the benchmark year, as the mean cost of production was higher than the mean gross return. With an increase in milk production over the years of experimentation, the net return also increased during subsequent years, and it was recorded highest Rs.13,494 during the third year of experimentation.

During the benchmark year, the participating households were not following any value addition & processing for their agricultural produce, and due to this, they were fetching lower prices for their produce in the market. The value addition & processing was initiated for coriander and vegetables before marketing by grading and packing, and it incurred additional cost, which ranged from Rs.2,870 to Rs.4,290 during different years of experimentation. By fol-

Table 1: Benchmark details of selected households (base year 2011-12)

Farming system	No. of household	Mean holding size (ha)	Mean family size (nos.)	Components		Mean total net income (Rs) before the start of the study per annum
				Crops	Livestock	
Crops + Dairy	10	0.72	5	Field crops, vegetable crops & horticulture crops	Dairy	77276

Table 2. Module-wise mean cost of cultivation, mean gross return, and mean net return over the years

	Crop module			Livestock module			Value addition & Processing module			Optional module		
	Mean cost of cultivation (Rs.)	Mean gross return (Rs.)	Mean net return (Rs.)	Mean cost of cultivation (Rs.)	Mean gross return (Rs.)	Mean net return (Rs.)	Mean cost incurred (Rs.)	Mean additional return (Rs.)	Mean net additional return (Rs.)	Mean cost incurred (Rs.)	Mean gross Return (Rs.)	Mean net return (Rs.)
Benchmark year	51985	137296	85311	64649	56615	-8034	-	-	-	-	-	-
First year	52307	161028	108720	88949	87829	-1120	3110	11201	8091	420	1825	1405
Second year	66159	197319	131160	89779	92079	2301	2870	11230	8360	645	2590	1945
Third year	69286	208192	138904	89655	103149	13494	4110	24024	19914	6082	16746	10664
Fourth year	72189	208289	136098	89923	100636	10713	4290	24029	19739	4970	18180	13210

Table 3: Mean total cost of farming systems, mean gross return from the farming systems, mean net return from farming systems, and mean benefit: cost ratio of farming systems of participating households over the years

	Mean total cost of farming systems (Rs.)	Mean gross return from the farming systems (Rs.)	Mean net return from farming systems (Rs.)	Mean B:C ratio of farming systems
Benchmark year	116,634	193,911	77,277	1.66
First year	144,786	261,883	117,096	1.81
Second year	159,453	303,218	143,766	1.90
Third year	169,133	352,111	182,976	2.08
Fourth year	171,372	351,134	179,760	2.05

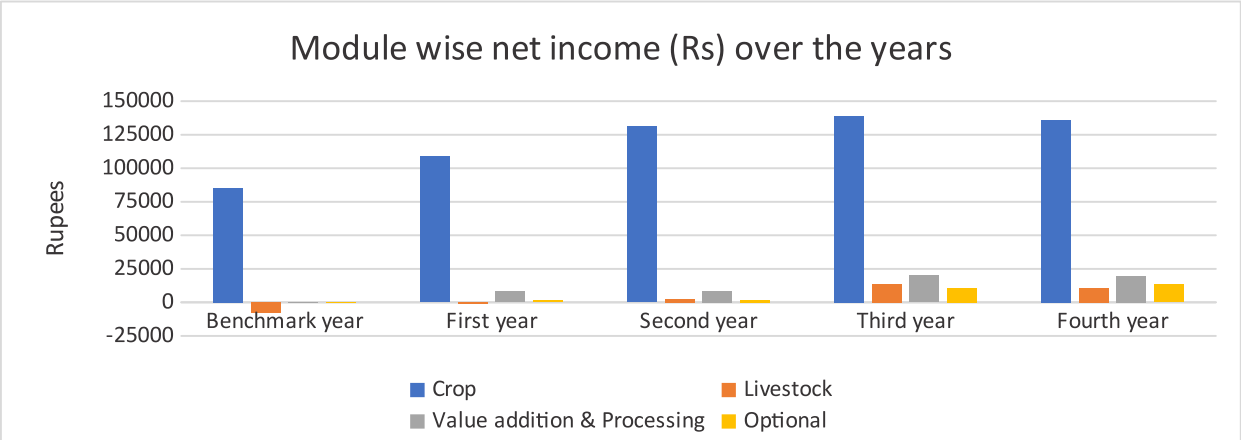

Fig.1: Module-wise net income (Rs) over the years

lowing value addition & processing for their agricultural produce, the participating households received a mean additional return from Rs.11,201 to Rs.24,029 during different years of experimentation. The mean net additional return from value addition & processing ranged from Rs.8,091 to Rs.19,914 during different years of experimentation.

Under the optional module, for the constraints of left-over unutilized space near households, no high value crops in farming systems and no utilization of cow dung following diversifications were followed in the existing farming systems of participating farmers: papaya and cucurbits production on left over space near the homes, coriander and chilli cultivation during summer/ rainy season, introduction of backyard poultry and vermi-composting. These diversifications incurred additional costs which ranged from Rs.420 to Rs.4,970 during different years of experimentation. The mean gross return from these diversifications increased over the years from Rs.1,825 in the first year to Rs.18,180 in the fourth year of experimentation. The mean net return from these diversifications in the farming system increased from Rs.1405 in the first year to Rs.13,210 in the fourth year of experimentation.

The results on the mean total cost of farming systems, mean gross return from the farming systems, mean net return from farming systems, and benefit: cost ratio of farming systems of participating households over the years have been presented in Table 3. The mean total cost of farming systems was Rs.116,634 during the benchmark year (2011-12), with additional costs on interventions and diversification, it increased over the years, and it was recorded highest (Rs.171,372) during the fourth year of experimentation (2015-16). The mean gross return from farming systems of participating households was Rs.193,911 during the benchmark year and it increased over the years and it was recorded highest (Rs.351,134) during fourth year of experimentation due to increased production in different module and due to additional income from value addition & processing of agricultural produce and additional income from diversification of farming systems of participating households. The mean net return also increased from Rs.77,277 during the benchmark year to Rs.179,760 during the fourth year of experimentation. The benefit-to-cost ratio also improved over the subsequent years from 1.66 during the benchmark year to 2.05 during the fourth year of experimentation. Ravisankar *et al.* (2022) also reported that an improved integrated farming system provided a wider array of livelihood security than the existing practices and provided better economic return. Jayanthi *et al.* (2009) also reported, based on farmer participatory research, that the IFS approach is better than the traditional system in its contribution to productivity, profitability, economics, and employment generation for small and marginal farmers of Tamil Nadu.

CONCLUSION

Based on this farmer participatory research in the

hills of Uttarakhand with small and marginal farmers, it may be concluded that improvement in the existing traditional farming systems by scientific interventions and diversification better productivity, profitability, and economics can be achieved.

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