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Impact of cluster-based technology transfer on profitability of ginger cultivation by small hill farmers of Shivalik region of Haryana

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Abstract

Ginger (*Zingiber officinale*) is an important commercial crop of Morni hills of Haryana Shivaliks. There was considerable gap between the actual yield and income than the potential indicated by successful growers. In an attempt to bridge this gap by adopting a cluster development approach, 32 ginger growers of a hill village were formed as a common group to implement the recommended package of practices based on soil test analysis and adopted over one bigha (1/12th of hectare) of 32 demonstration plots and one bigha was kept as untreated control with farmers' normal practice. The beneficiary farmers were provided trainings, exposure visits and interaction with agricultural experts. The average fresh ginger rhizome production in treated plots was 11.19 t ha^{-1} as against 6.97 t ha^{-1} in control plots. While 84 percent farmers obtained an yield of 11 to 12 t ha^{-1}, yield recorded by remaining farmers ranged from 7.44 to 9.63 t ha^{-1} thus indicating scope of further increase in production. The ratio between seed used and rhizome yield was taken as an indicator of yield potential and this was 4.04 in case of treated plots and 2.65 in case of control thus registering overall increase of 52.4 percent. The total gross and net returns were Rs 996678 and 395925 ha^{-1} and the average cost of cultivation was Rs 600753 ha^{-1}. The overall benefit cost ratio was 1.66. However, in case of control plots, the average gross and net returns were Rs 532800 and Rs 106972 with a benefit cost ratio of 1.22. In the cluster based approach, reduction in input costs and collective marketing resulted in better dividends.

Keywords: cluster approach, productivity, technology transfer, *Zingiber officinale*

Introduction

Foot-hills are always associated with landscape instability, ecological degradation, loss of productivity and biodiversity and water scarcity which add to the poverty and migration of people to other regions (Hannaway 1985). The Shivalik foot-hills region of north India is no exception. These are spread below the Himalayas and above the alluvial plains in a long and narrow belt across the states of Jammu and Kashmir, Punjab, Himachal Pradesh, Haryana and parts of Uttaranchal covering an area of four million hectare which suffers from serious problem of soil erosion, floods and droughts (Grewal 2002). In the state of Haryana, Shivaliks are considered as the crown of the state with good rainfall, natural forests and rich biodiversity of fauna and flora. However, there is acute water scarcity, low productivity of small size rain-fed land holdings and poor infrastructure (Grewal 1995; 2018).

Vegetable cultivation is common in *Kharif* season in several pockets of Shivalik hills of Haryana due to better climate and good seasonal rainfall. Ginger (*Zingiber officinale*) is an important spice crop of this area which is a precious gift of nature as its medicinal values are widely recognized and is a very important constituent of all vegetable preparations. Sharda (2016) reported that ginger remains a component of more than 50 percent of the traditional herbal remedies. The finest quality ginger comes from Kerala endowed with congenial climate and soils rich in organic matter. The states of Karnataka, Odisha, Assam, Meghalaya, Arunachal Pradesh and Gujarat together contribute 65 percent to the total ginger production in India. Assam being the largest in terms of area and Karnataka occupying 1^{st} rank in terms of productivity of 31.38 t ha^{-1}. As per APEDA 2022, the gross production in India was 1.918 million tons during 2021.

In north India, maximum ginger is produced in foothills area of Himachal Pradesh. Haryana produces only 7% of the total ginger production in India (Karthick *et al*. 2015) and the same is produced in the Shivalik foothills of the state. The ginger produced is mainly used for making ginger powder locally called s*aunth* (dried ginger).

It was noted through discussions with farmers that there was considerable gap between potential and actual crop yields of ginger. Such a gap could be bridged by innovative technology transfer and adoption of integrated package of practices. Hence a study was planned by taking one compact block of ginger growers where farmers were organized as common interest group and supported to adopt the complete technological package. The results of this study conducted during *kharif* crop growing season of 2018-19 with a group of 32 ginger growers are reported in this paper.

Material and Methods

Study area

Shivalik hills commonly known as Kandi-belt is spread across north-western states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Uttar Pradesh and union territory of Chandigarh at an elevation ranging from 217 to 2332 m above MSL. These are one of the youngest mountain ranges running parallel to the Himalayan ranges. The present study was conducted in Haryana region, which consists of part of north-eastern districts of Panchkula, Ambala and Yamunanagar and situated between 30°08'36" and 30°55'05" N latitude; and 76°36'05" and 77°34'48"E longitude between 276 m to 1480 m above msl covering an area of 1970 sq.km (Yadav *et al*. 2015). The area falls in the sub-tropical, agro-ecological zone, having extremes of temperatures in summer and winter. The mean maximum temperature is 42 ^{0}C and mean minimum is 5 ^{0}C. The average annual rainfall of the region varies from 800 to 1200 mm; about 80 percent of which is received from June to September. The soils belong to mixed hypothermic family of coarse loamy and typic ustochrepts. The soils in agricultural lands are sandy loam to loam and are highly prone to erosion. The fertility in general is poor.

Selection of cluster of ginger growers

In the Morni block, vegetable cultivation is concentrated in Bhoj Tipra, Bhoj Koti and Dharara Gram Panchayats covering about 35 small villages/hamlets. It was found that village Chaplana of Bhoj Koti Gram Panchayat has a compact block of 32 ginger growers and is famous for vegetable cultivation particularly ginger as a large chunk of land well terraced and irrigated by a *kuhul* (a natural flow-based irrigation channel) is available for intensive cultivation of vegetable crops. This compact block provided an opportunity to test the scope of technology transfer for maximizing profitability of ginger through recommended package of agricultural practices. Incidentally, all the 32 farmers having 60 acres (24 ha) of land under ginger cultivation were members of a farmer producer organization (FPO). It was planned to motivate the farmers for the adoption of scientific package of practices through awareness generation, demonstrations, trainings, exposure visits and regular interactions with experts. One bigha (833 sq m) was taken up as demonstration plot for testing the technology and one bigha taken as control with farmer's traditional method of cultivation.

It was decided to apply the recommended nutrients on soil test basis. The surface soil samples (0-15 cm) of all the 32 demonstration plots were collected and analyzed at the Soil Testing Laboratory of the Dept. of Agriculture, Haryana at Panchkula. The results were tabulated for all the farmers and a summary table was generated.

Cultivation as per recommended package of practices

The package of practices recommended by ICAR – Indian Institute of Spices Research, Kozhikode were followed in the study. Complete treatment against soft rot, bacterial wilt, and leaf spot diseases were provided as suggested by Krishi Vigyan Kendra based upon their research work at Manipur ICAR Research complex for NEH region. FAO (2019) provided a complete package of practices for successful ginger cultivation and suggested good drainage, sowing on raised beds, heavy mulching. The associate crops of turmeric, chillies and colocasia were raised as a common practice to get additional returns. It was suggested that ginger should not be raised in the same field year after year and farmers are already following this practice. The use of Ridomil Metalaxyl-Mancozeb, Mancozeb, Carbaxy chloride have been suggested for disease management. A list of inputs per bigha (one twelfth of a hectare) was finalized based on recommendations stated above. The average cost of inputs provided to 32 farmers was Rs 68184 (Table 1).

Table 1. Detail of inputs and cost (Rs) of demonstration plots

Particulars	Total cost of inputs (Rs)
Cost of seed treatment before planting	258960
Cost of soil sterilization with black polythene sheet	384300
Cost of bio-fertilizer, NPK and micro nutrients on soil test basis	524928
Cost of Trichoderma and neem cake	760320
Plant protection cost Mancozeb, Ridomil, Carbaxychloride, Bavis-tin	253440
Total cost of inputs	2181948
Input cost per farmer	68184

The rest of expenditure on cultivation, manure, irrigation and harvesting was taken as farmer's share of investment. The seed treatment was carried out as recommended by dipping in bavistin solution. FYM was added by the farmers and fields were prepared in the form of ridges and trenches and sowing was carried out at recommended spacing by the addition of vermicompost and neem cake. Heavy mulch of dry leaves and pine leaves was applied on the ridges. Since seed was not provided under the package, there was some variability in the quality of the seed material.

Capacity building of farmers

There was a provision of trainings, exposure visits and group discussions with experts. Regular group meetings were held with the farmers to share their experiences and to provide technical guidance. Each farmer kept proper record of inputs of treated and comparable untreated plots. Farmers were also advised telephonically whenever there was a problem.

Results and Discussion

Soil testing report of demonstration plots

It was noted that the average soil pH was 6.9 (normal) in the study area. The other important soil parameters and the nutrient status of the soil are presented in Table 2.

The soil test reports of all farmers were shared and results explained. The fertilizer doses in demonstration plants were designed based on soil analysis results.

Analysis of gap in crop productivity

Before this experiment, an analysis of ginger crop productivity levels in the area was carried out by taking the present production level and returns by collecting data from four typical farmers of a village. It emerged that ginger cultivation is profitable only when the yield is more than 12 t ha^{-1} (Table 3).

Two out of four farmers ended in loss due to low productivity and poor quality of produce. These farmers were not following proper package of practices. The ratio between raw ginger and *Saunth* (dried ginger) should be above 18% and quality of *Saunth* should be such that maximum yield is in (a) and (b) category of rhizomes to get a reasonable profit. Now the challenge was how all other farmers reach the level of 12 t ha^{-1} or a ratio of 18% and (a) & (b) category produce of *Saunth*.

Table 2. Summary table of soil health card data.

Soil class	pH	EC 1:2	OC%	N	P_2O_5	K_2O	S	Zn	Fe	Mn	Cu
1	7.02	0.76	0.53	136	28	171	28	1.8	23	6.8	1.5
2	6.87	0.65	0.44	113	32	126	25	2.1	28	6.9	1.7
3	6.97	0.71	0.49	124	28	168	30	2.0	28	8.6	1.5
4	6.68	0.60	0.40	103	30	159	28	1.9	36	10.2	1.7
5	6.89	0.63	0.43	111	31	157	34	1.9	28	2.6	1.3
Mean	6.9	0.67	0.46	117	30	156	29	12	29	8.1	1.5
	N	N	L	L	M	M	H	H	H	M	H

N=normal, L=low, M=medium, H=high

Table 3. Analysis of ginger production, cost of cultivation and net profit of four typical farmers*

Farmer Number	Production of ginger rhizome (t ha^{-1})			Production of ginger powder (t ha^{-1})	Percent of powder production	Cost of cultivation (Rs ha^{-1})	Sale price of powder (Rs)	Profit +/ loss- (Rs)
	New	Old	Total					
Farmer-1	10.404	1.992	12.396	2.268	18.3	663996	912000	+248004
Farmer-2	6.600	2.400	9.000	1.440	16.0	516200	576000	+59800
Farmer-3	4.596	1.608	6.204	1.042	16.8	420000	417600	-2400
Farmer-4	5.186	0.804	5.990	0.719	12.0	366396	288000	-78396

*Based upon data provided by ginger growers for 2018-19.

Impact of treatment package on plant health and vigor

In order to motivate the farmers, plant samples from demonstration plots and control plots were taken, washed and placed before the farmers for comparison. It was so evident that the demonstration plot plants were much healthier, taller, had more number of leaves and more number of tubers as compared with the plants of the control plots (Fig. 1 a,b).

Analysis of crop production data

After the harvest of demonstration and control plots, the ginger rhizomes were cleaned and weighed separately for each farmer. The data from 31 farmers were analyzed except for one farmer whose crop was completely damaged. There was 60.4 percent increase in rhizome production in treated plots as compared to control plots (Table 4).

Table 4. Production of ginger rhizomes in treated and control plots

Type of ginger produce	Production t ha^{-1}		Increase t ha^{-1}	Percent increase
	Treated	Control		
New rhizomes	9.312	6.048	3.264	54.0
Old rhizomes used as seed material	1.872	0.924	0.948	102.6
Total	11.184	6.972	4.212	60.4

The control data pertains to 26 farmers and rest five farmers had crop on only one bigha of treated plots. The average improvement in production of new bulbs was 54% over control. When taking old and new bulbs combined, the increase was 60.4 percent. The average yield of old bulbs was 1.872 t ha^{-1} in treated and only 0.924 t ha^{-1} in control giving increase of 102.6 percent. This clearly indicated that the farmers were using much less seed of ginger and hence low production.

Variability in ginger crop production

A wide variation in production of ginger both in treated and control plots were noted. While 45 percent A class farmers obtained rhizome yield up to 12.084 t ha^{-1} as compared to only 7.152 t ha^{-1} in case of control registering an increase of 68.9 percent (Table 5).

In case of 9.6-12 t ha^{-1} and 8.4-9.6 t ha^{-1} category farmers, there was 61.5 and 33.2 percent increase in production over control plots respectively and the overall increase was 60.4 percent. This implies that there was still scope for further increase in production from the level of <7.4 t ha^{-1} category farmers of 7.44 t ha^{-1} and C class farmers level of 9.636 t ha^{-1} to the level of more than 12 t ha^{-1} of >12 t ha^{-1} category farmers. The local variation in drainage system, seed material and fertility levels were responsible for low yield in 16 percent farmers. This is obvious when large number of farmers are involved.

Fig. 1. (1). Comparison of rhizomes from treated (disease free) and control plots (disease infected; (2). Health and vigor of plants from treated and control plots.

Table 5. Variability in production of different category of growers in treated and control plots.

Category of farmers as per average yield	No of farmers/ percent of total	Average production (t ha^{-1}) Treated	Average production (t ha^{-1}) Control	Average increase (t ha^{-1})	% increase
>12 t ha^{-1}	14 (45%)	12.084	7.152	4.932	68.9
9.6– 12 t ha^{-1}	12 (39%)	10.968	6.792	4.176	61.5
8.4–9.6 t ha^{-1}	4 (13%)	9.636	7.236	2.400	33.2
<7.4 t ha^{-1}	1 (3%)	7.440	---	---	---
Mean	31	11.184	6.972	4.212	60.4

Farmer's category scale is different in treated and control plots

Spatial variability in production levels

High variability in production levels of farmers was observed in spite of the fact that same type of inputs was used in all the demonstration plots. The yield level was as high as 12 t ha^{-1} and there were farmers who recorded more than 100% increase in yield though the overall average increase was 54 percent. There were six farmers who recorded only 20 to 30 percent increase in rhizome production. The potential for increase in production was further indicated by per cent increase over control which varied from less than 50 to more than 150% (Table 6).

Table 6. Percent increase over control attained by farmers.

Percent increase over control	No. of farmers
More than 150	1
100-150	7
50-100	8
Less than 50	10
Total	26*

*26 is the number of control farmers.

It is evident that production of an average 12 t ha^{-1} was possible provided good seed is used, proper drainage provided and package of practices meticulously followed. There was high variability in rhizome production with the same level of inputs and the reasons based on discussion with the farmers are given below.

a) There was very high variability among fields in terms of draining of excess water during rains. The fields having no accumulation of water and fields in the efficient drainage system produced more yield. In the low-lying fields, quick drainage was not possible and yield was low.

b) There were inherent differences in the fertility level of the fields translating to yield differences.

c) Some of the farmers were engaged outside the village and could not meticulously attend to spray schedules. The timely application of nutrients and timely spray is important and such farmers were not present to attend to those timely operations.

d) The seed of ginger was not provided by the project and the quality of seed was not the same. Healthy seed produced more yields.

Ratio between seed used and production obtained

Seed in ginger is the costliest input. A thumb rule was followed to estimate the yield potential which is the ratio between the seeds used and the yield obtained. Using the same analogy, the data of seed used and yield obtained in demonstration plots was compared. The overall ratio between seed used and rhizome production was 4.04 in case of treated plots and 2.65 in case of control thus registering overall increase of 52.4 percent (Table 7).

In case a farmer sells the rhizomes as seed, he produced 52.4 percent more than the control.

Table 7. Ratio between seed used and production obtained with different category of farmers.

Category of farmers	No. of farmers	Average ginger production t ha^{-1}	Ratio between seed used and produce obtained		
			Treated plots	Control plots	Percent increase
A class	14	12.084	4.10	2.50	64.0
B class	12	10.968	3.95	2.52	57.0
C class	4	9.636	4.06	2.94	38.0
D class	1	7.440	3.97		
Total/Mean	31	11.184	4.04	2.65	52.4

Gross and net returns and cost benefit ratio

The overall average fresh rhizome yield in demonstration plots was 11186 kg ha^{-1}, the proportion of dry ginger powder was 19.97 percent of fresh yield, average ginger powder yield was 2238 kg ha^{-1} having market value of Rs 895123 at the prevalent market rate of Rs 400 kg^{-1}. The average additional income from companion crops of turmeric, chilies, colocasia etc. was Rs 101555. The total gross and net returns were Rs, 996678 and 395925 ha^{-1} and at average cost of cultivation of Rs 600753 ha^{-1}, the overall cost: benefit ratio was 1:1.66 (Table 8).

However, in case of control plots, the average gross and net returns were Rs 532800 and Rs 106972 with cost benefit ratio of 1:1.22. Around 84 percent farmers of A and B category recorded net returns in the range of Rs 4.56 and Rs 3.84 lakhs ha^{-1} with cost benefit ratio of around 1:1.7. High benefit cost ratios have been given by some of the research workers where farmers preserved their own seed due to climate advantage. Raja Shekhar and Kumar (2017) reported that in Karnataka, the average cost of cultivation of ginger was Rs 204538 ha^{-1}, the gross returns varied from Rs 608000 ha^{-1} to Rs 633600 ha^{-1} and net returns varied from Rs 398228 to Rs 436036 ha^{-1} and cost benefit ratio was 1:3. Their net returns were almost similar as indicated in this study.

Chalise *et al*. (2019) reported productivity of ginger in Nepal as 14.81 t ha^{-1}, with cost benefit ratio of 1:2.06. The main problems identified by them included the high incidence of diseases, high input costs and market fluctuations. They concluded that ginger has high profitability and holds potential as agricultural enterprise. Shinde e*t al*. (2020) and Kadam *et al*. (2019) deliberated on the economics of ginger cultivation in a district of Maharashtra and reported that the productivity was 13.221 t ha^{-1}. The gross return was Rs 652044 ha^{-1}, the cost of cultivation was Rs 299856 ha^{-1} and farm business income was Rs 469644 ha^{-1}. The net income was more for farmers keeping their own seed. Mathew *et al.* (2016) also discussed the economics of ginger production in Kerala and reported similar results.

Dewanarayana and Wigilupure (2018) suggested that the price fluctuation, unavailability of quality seed, high price of fertilizers and other inputs, lack of scientific knowledge on farming and post-harvest handling and the inefficient extension services are the major challenges in ginger farming. It, however, has high potential in alleviating the rural poverty and hence its cultivation can be promoted as a major export crop with minimum environmental implications and ability to cultivate as a supplementary source of income with suitably absorbing the family labour. They recommended the introduction of high yielding short duration varieties, supply of planting material, reduction in yield gap, fast ginger processing, promotion of organic ginger production and strengthening agricultural research. Similar studies on ginger were conducted in different parts of the country.

Yadav *et al*. (2004) suggested very high commercial prospects for ginger cultivation in the North – Eastern states and provided an exhaustive overview of production, marketing problems and overall profitability for

Table 8. Average fresh rhizome yield, proportionate ginger powder production, gross and net returns and cost benefit ratio of different category of farmers of treated and control plots.

Category of farmers and average production (treated)	No. of farmers	Percent of total farmers	Average yield of rhizome (kg ha^{-1})	Percent of ginger powder	Average ginger powder production (kg ha^{-1})	Average gross returns @ Rs. 400 kg^{-1} (Rs ha^{-1})	Returns from allied crops (Rs ha^{-1})	Total gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	Cost benefit ratio
A = >12 t ha^{-1}	14	45	12084	20.3	2454	981600	117792	1099392	643200	456192	1.71
B = 9.6 – 12 t ha^{-1}	12	39	10968	19.8	2172	868800	95568	964368	580400	383968	1.66
C = 8.4 – 9.6 t ha^{-1}	4	13	9636	19.5	1879	751600	75160	826760	533780	293000	1.55
D = <8.4 t ha^{-1}	1	3	7440	19.3	1436	574400	51696	626096	519450	106646	1.28
Total/ Weighted mean	31	100	11186	19.97	2238	895123	101555	996678	600753	395925	1.66
2.Control D = <8.4 t ha^{-1}	26	100	6972	19.1	1332	532800	47952	580752	473960	1067922	1.22

improving economy of hill farmers. Mawlong (2017) discussed the issues of high cost of inputs in ginger cultivation, weed infestation, insect pest infestation, marketing and lack of extension services. The average production in one of the leading districts of Meghalaya was 8.3 t ha^{-1}. Due to very high cost of inputs and labour, the net profitability remained quite low. Sharath and Dhananjaya (2015) reported that ginger thrives well in well drained, friable loamy soil rich in organic matter being an exhaustive crop. They suggested that it is not desirable to grow ginger in the same field year after year. As reported by many others also (mentioned above), the ginger cultivation is highly profitable, hence the present study will be very useful in increasing the present yield-status of farmers as there is enough scope of increasing yield and profitability of the farmers of this region. It was observed that procurement of ginger seed from Himachal Pradesh turns out to be very expensive and also brings pathogens which when not treated properly results in huge yield loss. Low adoption of technological package due to poor financial conditions of farmers, marketing problems as farmers are cheated by the local traders, poor organizational ability for any collective initiatives, low risk bearing capacity and grossly inadequate extension services in the remote hilly area are the concerns which needs to be addressed. The main limitation for ginger production in Morni hills of Haryana is the preservation of ginger seed which is not possible due to high summer temperature and seed was purchased from upper hills which constitute about 30 percent of input costs.

Conclusion

Adoption of a cluster approach for transfer of technology generated positive results. The total gross and net returns in treated plots were Rs 996678 and 395925 ha^{-1}. At an average cost of cultivation of Rs 600753 ha^{-1}, the overall cost: benefit ratio was 1:1.66. However, in case of control plots the average gross and net returns were Rs 532800 and Rs 106972 with a cost benefit ratio of 1:1.22. Forty five percent farmers could get an average rhizome yield above 12 t ha^{-1} and another 39 percent between

9.6 and 12 t ha^{-1} with overall mean of 11.186 t ha^{-1} against 6.972 t ha^{-1} in case of control. The average ratio between seed used and produce obtained was 2.65 in control and 4.04 in treated plots thus registering 52.4 percent increase. Moreover, the variability in this ratio was much less in treated as compared to control plots. The study clearly brought out the scope of improving productivity and net returns of ginger by following the package of practices. This calls for the dire need of developing cold storage facilities to augment the profitability of ginger cultivation in this area. Organics should also be tried for disease management for which there are no clear recommendations as yet. It is recommended that technology generated and its economic benefits are demonstrated under real field conditions with focus on capacity building of farmers adopting cluster approach for better understanding of constraints in technology adoption.

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